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Corporate Financing Decisions: Innovative versus Non-Innovative Firms

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Abstract

This thesis uses a sample of 807 firms listed on the London Stock Exchange over the period 1987-2013 to investigate the differences in financing decisions, leverage adjustments and trade credit policies between innovative firms that report R&D and non-innovative firms that do not report R&D. This focus is motivated by the marked increase in intangible investments amongst firms in the UK, and the need to re-examine the overlooked interdependence of financing and investment decisions. The empirical analyses in this thesis use a combination of ordinary least squares with fixed effects (OLS FE thereon) and system Generalised Method of Moments (system GMM thereon) as the main estimation techniques. The results show that leverage is persistent, with innovative firms adopting similar financing structures as non-innovative firms despite being supposedly constrained. Further, innovative firms consistently adjust their leverage towards a target faster than non-innovative firms. This result suggests that innovative firms are more active in managing their capital structure, perhaps because they face higher costs of deviating from target relative to non-innovative firms. The results also show that innovative and non-innovative firms have different credit policies, where the former give (use) more (less) trade credit than the latter. Finally, analyses of time variation in leverage and credit adjustments, which are largely overlooked in the literature, suggest that such variations are important in understanding corporate decisions. This is especially pertinent given the economic shift from predominantly manufacturing based sectors towards technology and service based sectors. Overall, the results show that investment type has a significant effect on corporate decisions beyond the factors reported in the literature.

Keywords: capital structure, leverage adjustment, trade credit.

Dedication

To all those who were there for me throughout this journey.

Declaration Statement

ACADEMIC REGISTRY

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Chapter 1

Introduction and Overview

1.1 Motivation

Despite advancements in the literature, several questions on corporate financing decisions remain unresolved.[1] What are the determinants of capital structure? Do firms have a target financing structure? If they do, what is the speed of adjustment towards the target capital structure? What explains the observed divergence and the form of the divergence in financing patterns? Further, the transition of economies from predominantly manufacturing sectors towards service and technology sectors has raised new questions on how these changes in corporate investments affect financing decisions.[2] This economic transition entails a change in corporate balance sheets and composition of firms, which has implications on corporate decisions. Specifically, the marked increase in R&D, which has coincided with significant changes in corporate assets (e.g., decreases in tangible assets (collateral) and increases in intangible assets), should result in the adoption of conservative financing structures as managers use capital structure to manage operating risk. These predictions are in line with Krainer (2014) who formulates a model in which asset adjustments result in changes in expected income and operating risk of firms, and managers respond by adjusting capital structure to reduce or increase operating risk to levels that conform with the risk aversion of shareholders. However, firms appear not to reduce corporate debt in a way that offsets the increase in operating risks arising from the increase in R&D and the decrease in collateral (tangible assets). Rather, corporate debt has remained largely persistent with a general upward drift characterised by several spikes for both innovative and non-innovative firms.[3] The seemingly contradictory trends in corpo-

[1]Recent reviews highlight several limitations in the extant literature which include mixed results even within the US where studies are more concentrated, mis-specified models, mis-measurement of variables, low explanatory power of existing models and omission of important factors such as the role of non-financial stakeholders, financial contracts, and value effects of leverage (see, Frank and Goyal, 2009; Graham and Leary, 2011; Oztekin, 2015; Parsons and Titman, 2007).

[2]Several report marked increases in the proportion of firms is undertaking innovative investments as economies shift towards service and technological sectors (e.g., Aghion et al., 2004; Damodaran, 1999, 2009; Lim et al., 2014; Moshirian et al., 2013; Sporleder et al., 2002).

[3]The rise in intangible investments (with low collateral values), which are more prone to asset substitution and information asymmetry problems, should be accompanied by a decrease in corporate leverage. However, contrary to these expectations, the appetite for corporate debt (leverage) in the UK has not subsided, but has been increasing from an average of 13% in the 1980s to over 17% just before the onset of the recent global financial crisis (as shown in Figure 3.1 of Chapter 3). Similarly, several studies in the US also report marked increases in corporate gearing (debt-to-equity ratios) over time (e.g., Almeida et al., 2012; Campello et al., 2010, 2011a,b; Carmassi et al., 2009; Chava and Purnanandam, 2011; Dang et al., 2014a; Kahle and Stulz, 2013; Miglo, 2013). In particular, Graham

rate investments and financing structure highlight the need for a detailed study of the linkages between financing and real decisions.[4]

The marked changes in corporate investments and their implications on corporate decisions have been largely overlooked in the literature, with most studies focusing on fixed capital investments.[5] Yet, this decrease in collateral and increase in intangible investments appear to be a long-term phenomena that has not resulted in marked changes in corporate financing decisions. Moreover, studies on the relationship between fixed capital investments (real decisions) and financing decisions often adopt a *ceteris-paribus* framework over short horizons (see, Dammon and Senbet, 1988; Dang, 2011), which, according to Buera and Kaboski (2012), does not capture changes in firm compositions in the long-run.[6,7] Using the predictions of the model by Krainer (2014), innovative firms should respond to the increasing risk in their investment portfolio by adopting conservative financing policies as firms use capital structure to manage risk. According to Aghion et al. (2004), firms with a low propor-

et al. (2015) report a threefold increase in corporate debt for non-financial firms in the US over the past century, while DeAngelo and Roll (2015) report a wholesale abandonment of conservative financing policies in the US after the Second World War. Further, Custódio et al. (2013) report a significant shift by firms in the US from long-term debt to short-term debt, which is inconsistent with the increase in operating risks due to changes in corporate investments.

[4]Chava and Roberts (2008) and Stein (2003) highlight that despite the existence of a general consensus that financing activities and real decisions are interdependent in the presence of market imperfections, the exact nature of the relationship is subject to debate.

[5]The change in corporate investments is marked by a surge in R&D to levels that match or exceed capital expenditure, and a decrease in tangible assets coupled with a significant increase in intangible assets. Borisova and Brown (2013) report a fourfold increase in R&D among young firms and a twofold increase for mature firms in the US over the period from 1980 to 2001. Similarly, Brown and Petersen (2011) report a significant increases in R&D from 2% over the period 1970-1981 to 6.3% between 1982 and 1993, with R&D increasing further to 10.3% from 1994 to 2006 in the US. Several other studies in the US report similar marked increases in R&D (e.g., Brown and Petersen, 2011; Falato et al., 2013; Sporleder et al., 2002). Although studies on the changes in corporate investments outside of the US are limited, Brown et al. (2012) report that over the period 1995-2007 firms in Europe spend one and half times more on R&D relative to physical capital.

[6]The relationship between capital structure and corporate investment is contentious (see, Chava and Roberts, 2008; Stein, 2003) as studies report mixed and inconclusive results, with one group of studies reporting a positive relation (e.g., Caglayan and Rashid, 2014; Lyandres and Zhdanov, 2005), while another reports a negative relation (e.g., Aivazian et al., 2005; Dang, 2011; DeAngelo and Masulis, 1980; Lang et al., 1996). This leaves the question of how do investment (financing) decisions affect financing (investment) decisions largely open to debate.

[7]Recent studies over relatively long periods by Frank and Goyal (2009) and Graham et al. (2015) report interesting changes on corporate financing decisions as the significance of some determinants of capital structure decreases considerably over time. For example, Frank and Goyal (2009) report that firm size, growth and inflation are becoming unreliable determinants of capital structure. Recently, Buera and Kaboski (2012) highlight that studies in corporate finance that only focus on changes within firms tend to overlook the important effects of changes in the composition of firms on the dynamics in cash holdings over time.

tion of tangible assets and risky investments are less reliant on debt financing as they are more likely to have high bankruptcy costs. The trade-off theory posits that firms have an optimal capital structure that is a result of balancing the marginal benefits of debt (tax shields) with the marginal costs of financial distress (bankruptcy costs).[8] Following on this prediction, innovative firms are, thus, more likely to actively adjust capital structure towards the target as they face high costs of deviating from the target. This prediction will be examined in this thesis by comparing the speed of adjustment of innovative and non-innovative firms, both cross-sectionally and over time. The market timing theory also posits that market timing increases with information asymmetry, which suggests that innovative firms that have more opaque investments should show high levels of market timing behaviour (see, Alti, 2006; Baker and Wurgler, 2002; Dittmar and Thakor, 2007; Elliott et al., 2008; Jung et al., 1996; Heaton, 2002; Myers, 2003). Further, the theoretical literature suggests two main channels through which financing decisions of firms with unique investments (innovative firms) may differ from traditional firms (non-innovative firms). These channels are: information asymmetry problems (see, Myers, 1984; Myers and Majluf, 1984) and control rights (see, Aghion and Bolton, 1992; Hart and Moore, 1995).[9] Empirical studies are yet to systematically test these theoretical predictions.

This thesis fills the gap in the literature by investigating the differences in financing structure, leverage adjustments and trade credit policies between innovative firms that report R&D and non-innovative firms that do not report R&D. Further, the majority of extant studies focus on the US, which limits the generalisability of the results to other economies that have different legal, institutional and macroeconomic environments. Oztekin and Flannery (2012) report that legal, institutional and macroeconomic factors have a significant effect on capital structure. Similarly, a survey by

[8]See, Bradley et al. (1984), Brennan and Schwartz (1984), DeAngelo and Masulis (1980), Goldstein et al. (2001), Hennessy and Whited (2005), Ju et al. (2005), Kane et al. (1984), Kraus and Litzenberger (1973), and Strebulaev (2007).

[9]The control rights proposition posits that when a firm has less tangible assets (more intangible assets), outside investors will insist on having control rights over the firm's decisions so as to satisfy their ex-ante participation with incomplete information (Hart and Moore, 1995). This may result in innovative firms relying more on retained earnings and debt financing, which all do not result in dilution (via heavily discounted equity issues) or the need to cede control to outside investors in a bid to satisfy their ex-ante participation constraint.

Graham and Harvey (2001) emphasises the need for concerted research efforts in smaller sub-samples in view of the failure of large cross-sectional studies in explaining the observed variations in corporate capital structure. The de-compositional approach used in the analyses in this thesis allows for an examination of the degree to which the different forms of corporate investment explain the observed variations in corporate decisions (financing structure, leverage adjustments and trade credit policies). The empirical studies in this thesis on the effect of changing firm composition and corporate investments on corporate decisions, adds new insights on the evolution of the relationship between financing and investment decisions.[10] The analysis of Chapter 4 will examine whether innovative firms use less debt financing than non-innovative firms as predicted by the information asymmetry proposition (see, Myers, 1984; Myers and Majluf, 1984), or more debt financing as advocated by the control rights proposition (see, Aghion and Bolton, 1992; Hart and Moore, 1995). Further, the analysis of Chapter 5 examines the prediction of the trade-off theory that the speed of adjustment increases with costs of deviating from a target capital structure. Following on the predictions of the trade-off theory, innovative firms that are likely to face higher costs of deviating from target and bankruptcy costs should more actively adjust leverage towards the target than non-innovative firm (that face relatively lower bankruptcy costs). Similarly, Faulkender et al. (2012), Leary and Roberts (2005) and Strebulaev (2007) report that firms adjust leverage faster if the benefits outweigh the associated costs of adjusting towards the target. We examine this prediction by comparing the speed of adjustment for innovative and non-innovative firm and over time. The focus on time variations adds new insights on the evolution of corporate financing decisions that have not been examined in the literature.

The following sections present a summary of the main contributions of the thesis and an overview of its structure.

[10] The rising corporate debt levels is an empirical irregularity that raises interesting questions on how changes in corporate investments affect financing structure. In addition, questions on how managers decide on capital structure (Myers, 2003) and whether capital structure affects real decisions such as investment (Lang et al., 1996) or firm value (Korteweg, 2010; Van Binsbergen et al., 2010) still remain open to debate despite decades of extensive research.

1.2 Main contributions

This thesis contributes to the literature on financing decisions through three interrelated empirical studies on financing structure, leverage adjustments, and trade credit policies. The focus on how different types of corporate investment affect corporate decisions, in particular, financing structure, target financing and trade credit policies, provides new insights on the relatively unexplored interdependence between financing and investment activities and time variations in corporate decisions. The need to understand this interdependence in corporate decisions and how it changes over time is increasingly becoming important in light of the marked changes in corporate investments and corporate balance sheets as economies shift towards technological and service sectors.[11]

The first contribution of the analyses is the documentation of evidence of an evolving relationship between financing and investment decisions. There is limited prior work on the interdependence of corporate decisions, and where considered, has mostly been under a *ceteris-paribus* condition that does not account for the dynamic nature of corporate decisions. This study fills this gap in the literature by adopting a de-compositional analysis to examine financing decisions and the determinants of financing structure. Further, the study compares the financing decisions of innovative and non-innovative firms in the UK over a relatively long period from 1987 to 2013.[12] The focus on the differences between innovative and non-innovative firms provides new evidence on the evolving nature of the relationship between financing and investment decisions. The results show that leverage has remained persistent with an upward drift despite the marked increase in R&D and decrease in collateral values (tangible assets). This result is inconsistent with theoretical predictions

[11] Recent models by Buera and Kaboski (2012) and Krainer (2014) show that changes in the economy and corporate investments have significant effects on cash holdings and risk management policies.

[12] The application of a de-compositional approach on leverage (leverage is divided into total debt, net-debt, long-term debt or total liabilities) is in line with Welch (2004) who highlight that while leverage on aggregate may exhibit relative stability or persistence over time, as Lemmon et al. (2008) and Hanousek and Shamshur (2011) report, its components show greater variability over time. Similarly, DeAngelo and Roll (2015) report that the observed stability in leverage is a temporary phenomenon which only occurs at lower levels of debt financing as firms actively change their capital structure in the long-run.

that firms reduce leverage to manage increases in operating risk (see, Krainer, 2014) arising from changes in a firm's investment portfolio. However, leverage increases with intangible assets in a similar way as with tangible assets. Further, the thesis reports significant time variation in the relationship between financing structure and corporate investments. This, previously overlooked feature, helps explain the mixed results in the literature that is split between studies that report a positive relationship and others that report a negative relationship between financing structure and investment decisions.[13] This investigated aspect on time variations adds new insights on the relatively overlooked effects of changes in firm characteristics on corporate decisions, more specifically, financing policies.

The second contribution is the quantification of the speed of adjustment, and the degree to which different types of corporate investment (R&D and capital expenditure) affect target financing behaviour and time variations in the speed of adjustment. Empirical evidence reported in the literature on target financing behaviour is decidedly mixed, and is often reported through analyses of short-time horizons (mostly 5-year periods), which does not allow for an adequate examination of the effect of changes in firm compositions on leverage adjustments. By examining one source of heterogeneity (differences in corporate investments) in leverage adjustments that has not been considered in the literature, this thesis provides the first attempt at understanding how investment types affect target financing behaviour, thereby, adding insights on the often contentious relationship between financing and real decisions.[14] Time variations in leverage adjustments have been overlooked in the literature, which has focused mostly on cross-sectional variations. A study of the time variations in the

[13] The results in the extant literature on the relationship between investment and financing decisions are rather mixed (see, Dammon and Senbet, 1988) as Caglayan and Rashid (2014) and Lyandres and Zhdanov (2005) report a significant positive relationship while Aivazian et al. (2005), DeAngelo and Masulis (1980), Dang (2011) and Lang et al. (1996) report a significant negative relationship.

[14] Ever since the irrelevancy theorem of Modigliani and Miller (1958) and the 'separation principle' which are premised on the proposition that financing and investment decisions are made independently (see, Jackson et al., 2013), the linkages between financing activities and real decisions in the presence of market imperfection are still ambiguous (see, Chava and Roberts, 2008; Stein, 2003). Although several studies have converged on the idea that the financing and real decisions are not independent, especially in the presence of market imperfections (e.g., Kim, 1978; Krasker, 1986; Kraus and Litzenberger, 1973; Miller, 1977; Modigliani and Miller, 1963; Myers, 1984; Myers and Majluf, 1984; Scott, 1976), the exact channels through which they relate is a subject of considerable debate (Stein, 2003).

speed of adjustment provides information on the ease with which firms can access financing, and how access to capital markets affects target financing behaviour.[15]

The final contribution of this thesis emerges from empirical analyses of the determinants of trade credit and time variations in the relationship between trade credit and short-term debt, and between trade credit and cash holdings. These analyses also compare trade credit decisions and trade credit adjustments between innovative and non-innovative firms. The focus on the time variation in the sensitivity of trade credit to cash and short-term debt is motivated by the considerable debate on whether trade credit is a substitute or a complement to other forms of financing (see, Ferrando and Mulier, 2013; Giannetti et al., 2011; Love et al., 2007; Yang, 2011b).[16] The analyses extend the literature by showing that there are significant time variation in the relationship between trade credit and other forms of financing. Further analyses that use partial adjustment models are conducted to examine the trade credit adjustments. A reported slow to moderate speed of adjustment supports the existence of adjustment costs, which impede firms from fully adjusting towards the optimal credit level. Dynamic adjustments in trade credit have largely been overlooked in the literature despite the importance of trade credit in alleviating product market and capital imperfections, and that customers who are accustomed to getting goods on credit expect this practice to continue.

Overall, the asymmetries arising from corporate investments that are the focus of this thesis have been overlooked in the literature, yet, our results show that they are a significant factor in understanding heterogeneity in corporate financing decisions. This result is new to the literature and remains significant even after controlling for other factors affecting corporate financing decisions.

[15]Recently, Faulkender et al. (2012) highlight the need to distinguish active leverage adjustments (arising from accessing capital markets to issue or retire securities) from passive changes (due to changes in operations or profitability) in capital structure so as to provide more focused tests of theoretical predictions on target financing behaviour. Similarly, Hovakimian et al. (2004) and Hovakimian and Li (2010) highlight that it is better to focus on refinancing points when studying financing decisions.

[16]Meltzer (1960) and Yang (2011b) report that the relationship between trade credit and short-term debt changes with the monetary policy.

1.3 Policy implications

The results in this thesis show significant differences in capital structure, target financing behaviour, and trade credit policies between innovative and non-innovative firms. These differences in financing policies have important policy implications considering the increasing dominance of the technology and service sectors.

The slow-to-moderate speed of adjustment reported from the analyses in this thesis should be a major concern to both managers and policymakers as the speed of adjustment is an indirect indicator of the level of financial constraints. This slow-to-moderate speed of adjustment that we report suggests that firms in the UK still face considerable levels of financial constraints that deter them from fully adjusting towards the target. Further, investors need to take into consideration the capital structure of the firm when evaluating investments as deviating from optimal capital structure has significant negative effects on firm value. The costs of deviation from the target increase with bankruptcy or financial distress costs that are relatively higher for innovative firms. The slow-to-moderate speed of adjustment suggests "inertia" on the part of managers and that firms still face significant adjustments costs. Further, the results also show that the "inertia" is relatively higher for non-innovative firms that can potentially engage in non-value maximising activities such as abuse of free-cash flows given that they face lower financial constraints and bankruptcy costs. Focusing on the "inertia" in adjusting capital structure towards the target, investors should put pressure on firms to ensure that the managers actively adjust towards the optimal capital structure. Investors can engage in shareholder activism that will force managers to actively adjust towards the target and maximise shareholder value. At policy level, policymakers should actively implement reforms that help ease the significant financial constraints faced by firms, especially, firms that invest in innovation. The reforms could take the forms of regulations that allow for new instruments to finance innovation as most innovative firms lack the collateral required to access financing under collateral-based lending approaches.

The significant decrease in trade credit should be worrisome to both small firms and policymakers alike as it has traditionally been a major form of financing for small or constrained firms that cannot access bank loans or capital markets. This decrease in trade credit highlights the need for firms that ordinarily relied on trade credit to look elsewhere for short-term financing. The decrease negatively affects the growth of small firms, which will reduce economic growth since small firms employ a significant proportion of the labour force and are a major driver of economic growth. Further, the decrease in trade credit will also harm innovation as most of the innovation is made by small firms that have limited access to traditional sources of financing. Banks can help by providing readily accessible short-term debt on favourable terms to small or constrained firms if there is government support or guarantees. Policymakers can help reduce financial constraints faced by small firms either through implementing regulations that promote the financing of innovating or by setting up new funds or financial structures that are earmarked towards small or constrained firms.

The results also show a significant increase in intangible assets as the economy is increasingly shifting towards technology and service sectors. This shift implies that firms will face binding financial constraints as they have less tangible assets that can be pledged when accessing bank loans. Policymakers can further promote the lending against intangibles by putting in place enabling legislation for banks to extend loans collateralised by intangible assets. The need to channel capital towards technology and service sectors is increasingly becoming more apparent as economies are shifting towards technology and service sectors. Further, the financing of innovation should be prioritised as it has several positive spill-over effects on other sectors and economic growth.

Overall, the results in this thesis show a marked shift in corporate investments towards intangibles, which may expose firms to binding financing constraints given that traditional forms of financing such as trade credit have decreased as well. This calls for an implementation of reforms that are aimed at increasing access to capital markets of firms that would not ordinarily get financing under the collateral-based-lending approaches currently being used by banks.

1.4 Data and research methodology

The sample used in the analyses of this thesis consists of 817 firms (8,396 firm-year observations) in the manufacturing, extraction and construction sectors listed on the main official list of the London Stock Exchange (LSE) over the period 1987-2013.[17] The data on all firm specific variables is drawn from Worldscope through Datastream, while that of macroeconomic variables is drawn from the Bank of England. The sample period is restricted by data unavailability as the reporting of R&D only became compulsory in 1989 in the UK (see, Aghion et al., 2004). The focus on the UK is motivated by the concentration of studies on the US, which limits the generalisation of results to other economies.[18] The sample spans a comparatively long period of 27 years which allows for an examination of the effects of changes in firm composition on corporate decisions.[19]

In this thesis, panel data models are used to investigate the factors that affect financing and trade credit policies. Using panel data allows for modelling of cross-sectional dynamics over time, while simultaneously controlling for the potential endogeneity of the variables used. Prior studies on corporate decisions rely on panel data models that include fixed effects to control for unobservable time-invariant features of the firms (e.g., Antoniou et al., 2006; Brav, 2009; Cook and Tang, 2010; Dang et al., 2012; Denis, 2011; Faulkender et al., 2012; Flannery and Rangan, 2006; Lemmon et al., 2008; Ozkan and Ozkan, 2004; Oztekin, 2015). In this thesis, the models are estimated using a combination of ordinary least squares with fixed effects (OLS FE thereon) and system Generalised Method of Moments (system GMM thereon),

[17] Several studies exclude the financial and utility sectors that are heavily regulated (e.g., Fama and French, 2002; Frank and Goyal, 2009; Korajczyk and Levy, 2003; Oztekin, 2015). According to Brav (2009), the exclusion of the financial and utility sectors allows for a more focused analyses of companies with organisational structures that are most relevant to capital structure theories.

[18] Antoniou et al. (2008), Oztekin (2015) and Oztekin and Flannery (2012) report macroeconomic and institutional have a significant effect on corporate decisions.

[19] Recently, Buera and Kaboski (2012) highlight that studies over short periods tend to overlook important dynamics on the effect of changes in firm compositions on liquidity management decisions.

with the system GMM being used as the main estimation technique.[20] However, results using other estimation techniques such as ordinary least squares (OLS thereon) (Dang, 2013a; Dang et al., 2014a; Ghaly et al., 2015; Love et al., 2007), Anderson Hsiao Instrumental Variables (AH IV thereon) (Dang et al., 2014a), Instrumental Variable Generalised Method of Moments (IV GMM thereon) (Baum et al., 2006), Difference Generalised Method of Moments (DIFF GMM thereon) (Dang et al., 2012, 2014a) and Fractional Dependent Variable (DPF thereon) (Elsas and Florysiak, 2013) are also presented in appendices, where applicable, for robustness and to facilitate comparisons with prior studies that use similar estimation techniques. Further, following Hovakimian et al. (2001) and Hovakimian and Vulanovic (2010), estimation results are reported on the probability of issuing or retiring debt and equity through probit regressions with a binary dependent variable that is equal one if a firm issues or repurchases debt or equity, and zero otherwise.

1.5 Structure of the thesis

This thesis consists of seven chapters. Chapter 2 presents a review of the literature. It motivates the analyses in this thesis by discussing the main strands in the literature and identifying relevant gaps therein.

Chapter 3 presents a description of the data, the data screening process used, and variable definitions. The chapter also presents information on the sample composition and trends on the variables used in the analyses, and concludes by presenting a summary of the characteristics of the data used in the three empirical chapters (Chapters 4, 5 and 6).

Chapter 4 contains the first empirical analysis, which investigates the determinants of financing structure and the differences in financing structure between innovative and non-innovative firms. The analysis also investigates time variations in the relationship between leverage (including its components) and corporate investments,

[20]Several studies in corporate finance use similar estimation techniques (e.g., Dang, 2013b; Faulkender et al., 2008; Flannery and Hankins, 2013; Huang and Ritter, 2009; Oztekin and Flannery, 2012).

and the determinants of the probability of accessing capital markets.

Chapter 5 contains the second empirical analysis which examines the speed of adjustment of leverage to a target level with a focus on the differences in target financing behaviour between innovative and non-innovative firms. The chapter then presents an examination of the effects of asymmetries (over-levered and under-levered firms) and financing deficits on leverage adjustments. Finally, the chapter presents an investigation of the time variation in the speed of adjustment.

Chapter 6 is the third empirical chapter. It presents an analysis of the determinants of trade credit, trade credit adjustments and the differences in trade credit policies between innovative and non-innovative firms. The analysis also examines the relationships between short-term debt and trade credit, and cash holdings and trade credit, and how these relationships change over time. Finally, the chapter presents an investigation of trade credit adjustments.

Chapter 7 presents a summary of the main findings and concludes with suggestions for future research.

Chapter 2

Literature Review

2.1 Introduction

This chapter presents a review of the literature on corporate financing and trade credit decisions. The attention devoted to the study of corporate finance decision making highlights that financing decisions are amongst the most important corporate decisions. Although the literature investigates the determinants of the financing structure (which includes firm characteristics and macroeconomic conditions), the question on how firms decide on capital structure remains open to debate.[1] This chapter presents a review of literature which motivate the research in this thesis. The rest of this chapter is structured into two sections. Section 2.2 presents a review of the main research themes and results on capital structure. Section 2.3 presents a review of the literature on trade credit that highlights the main themes and results of prior studies.

2.2 Capital structure: Literature review

2.2.1 Capital structure theories

The Modigliani and Miller theory

The seminal work of Modigliani and Miller (1958) on capital structure irrelevancy (MM theory henceforth) marked the beginning of formal studies on corporate financing decisions. The MM theory posits that real decisions, such as those on corporate investment, are independent of financing decisions (the mix of debt and equity) in perfect market.[2] According to Modigliani and Miller (1958) any differences in firm values arising from differences in capital structure are eliminated through arbitrage as investors engage in "home-made gearing" by borrowing and lending on their personal accounts. This arbitrage-based irrelevancy proposition in which investors undo any increase in firm value arising from an increase in gearing through "home-made

[1] Recent surveys highlight the mixed results in the literature and low explanatory power of existing models of capital structure (e.g., Frank and Goyal, 2009; Graham and Leary, 2011; Oztekin, 2015; Welch, 2011). Similarly, several studies (e.g., Frank and Goyal, 2007b, 2009; Myers, 2003) highlight that the major limiting factor in the understanding of how firms make financing decisions is the lack of a unified theory of capital structure in the presence of several competing propositions.

[2] In perfect markets there are many market participants, no transaction costs, no taxes and borrowing or lending at the risk free rate.

gearing" or "in multiple equilibria" supports the hypothesis that financing decisions have no effect on firm value (see, Auerbach and King, 1983; Miller, 1977).

The prediction of the MM theory that financing decisions have no effect on firm value generated a huge debate which divided scholars into two broad groups. Miller (1991) argues that managers should not worry over "second-order" and largely "self-correcting problems" such as capital structure.[3] Similarly, Korteweg (2010) and Van Binsbergen et al. (2010) report low marginal net contributions of capital structure to firm value, with estimates of 4% and 3.5% on average, respectively. Graham and Leary (2011) also highlight that changes in leverage have a small effect on firm value. However, several scholars subsequently criticised the narrow view of financing decisions in the MM theory (e.g., Jensen, 1986; Modigliani and Miller, 1963; Myers, 1977; Shleifer and Vishny, 1992).[4] According to Miller (1988) the MM theory shows, by implication, the factors that are important through highlighting the conditions under which financing decisions do not affect firm value (in perfect capital markets). The dis-satisfaction with the central predictions of the MM theory has resulted in the emergence of several other theories (which include the trade off theory, pecking order theory and market timing theory) that predict a significant effect of financing decisions on firm value. Literature on these theories is reviewed next.

Trade-off theory

The trade-off theory posits that firms decide on the optimal capital structure by balancing the marginal benefits of debt (mainly the tax-deductability of interest on debt) with the marginal costs of financial distress (see, Bradley et al., 1984; Brennan and Schwartz, 1984; DeAngelo and Masulis, 1980; Goldstein et al., 2001; Hennessy

[3]Several studies on the relationship between financing and investment decisions report mixed results. For example, Mauer and Triantis (1994) report an insignificant relationship while Lyandres and Zhdanov (2005) and Rashid and Caglayan (2012) report a significant positive relationship and Aivazian et al. (2005), Dang (2011), DeAngelo and Masulis (1980) and Lang et al. (1996) report a significant negative relationship. Chava and Roberts (2008) and Stein (2003) highlight that the ambiguity on the relationship arises from difficulties encountered in establishing the exact channels through which financing activities affect real decisions (such as investment or hiring) in the presence of market imperfections.

[4]Harris and Raviv (1991) offer a rich review of studies that show the failure of the irrelevancy theorem in imperfect capital markets.

and Whited, 2005; Ju et al., 2005; Kane et al., 1984; Kraus and Litzenberger, 1973; Strebulaev, 2007). This further incorporation of taxes in the original MM theory by Modigliani and Miller (1963) shows that firm value increases with debt. The implication of trade-off theory is that firms should finance their operations entirely with debt if there are no offsetting costs to debt. However, an increase in debt exposes firms to higher levels of financial distress or bankruptcy costs which may offset the benefits of using debt. In the presence of such costs, the optimal capital structure is a result of a trade-off between the benefits and costs of using debt (Kraus and Litzenberger, 1973). Further extensions of the trade-off theory to incorporate other benefits of debt, such as the disciplinary role of debt on the potential abuse of free cash-flows by managers (see, Jensen, 1986; Jensen and Meckling, 1976) and the mitigation of shareholder-manager conflicts (see, Stulz, 1990), show that firms seek to balance the financial distress costs and the benefits of using debt. Given these predictions of the trade-off theory, we posit that innovative firms are more likely to adjust their capital structure faster than non-innovative firms as they face high bankruptcy costs and high costs of deviating from the optimal capital structure. This prediction is in line with Borisova and Brown (2013), Brown et al. (2012) and Moshirian et al. (2013) who report that innovative investments are more susceptible to high information asymmetry, asset substitution, longer investment horizons, and low pledgeable value issues. These characteristics increase bankruptcy costs and costs of deviating from the optimal capital structure, which would motivate innovative firms to actively rebalance capital structure.

Pecking order theory

Unlike the trade-off theory which assumes that firms have a target capital structure, the pecking order theory posits that capital structure is a result of distinctive preferences for different financing sources (internal and external sources). The prevalence of information asymmetry and adverse selection costs in financial markets results in firms preferring internal to external financing sources as firms seek to minimise the adverse costs of security issuance (Myers, 1984; Myers and Majluf, 1984).[5] The

[5]The pecking order is attributed to an article by Donaldson (1961).

theory postulates that financing costs increase with asymmetric information. This results in hierarchical ranking of financing sources, with retained earnings being most preferred, followed by debt and lastly, equity. Adverse selection models by Myers and Majluf (1984) motivate the hierarchical preferences through the argument that, due to information asymmetry, investors always view the firm as being overvalued and managers as opportunists who want to take advantage of them by issuing overvalued securities. The low value attached by investors to new equity issues, which results in under pricing, highlights that information asymmetry is the main driver of the hierarchical preferences in the pecking order theory.[6]

The predictions of the pecking order theory point towards managers accumulating financial slack (retaining earnings) so as to avoid having to issue securities (in unfavourable periods) and incur issuance costs (Leary and Roberts, 2010). The presence of transaction costs and differences in required rates of return results in hierarchical preferences as predicted by the pecking order theory.[7] Given the direct variation of financing costs (issuing costs, required rates of return and dilution costs) with information asymmetry, firms seeking to maximise profits will show higher preferences for internal financing sources than external alternatives.[8] The pecking order hierarchical ranking of financing sources should be more significant for innovative firms that have higher levels of information asymmetry than for non-innovative firms. This should result in innovative firms being more reliant on retained earnings, followed by debt, and lastly equity. Equity is likely to be more costly to issue for innovative firms (leads to dilution as new investors would only buy shares if they are heavily discounted) as the new investors will insist on having more control rights to compen-

[6]Several studies report underpricing of initial public offerings (IPOs thereon) due to information asymmetry (see, Beatty and Ritter, 1986; Bessler et al., 2014; Ljungqvist and Wilhelm, 2003; Loughran and Ritter, 2002; Ritter and Welch, 2002; Ritter, 2003).

[7]The significance of transaction costs is diminishing due to technological advancements and market integration. However, Philippon (2015) reports that the cost of intermediation in the US has increased (remained relatively unchanged in some periods) in a way which suggest that improvements in information technologies have not filtered through to capital markets.

[8]The control rights proposition posits that when a firm has less tangible assets (more intangible assets), outside investors will insist on having control rights over the firm's decisions so as to satisfy their ex-ante participation with incomplete information (Hart and Moore, 1995). Further, the required rate of return increases with information asymmetry (see, Borisova and Brown, 2013; Brown and Petersen, 2009, 2011; Brown et al., 2012; Moshirian et al., 2013).

sate for the inherent high levels of information asymmetry associated with innovative investments (see, Aghion and Bolton, 1992; Hart and Moore, 1995). Information asymmetry results in the persistent underpricing of new issues, with this underpricing being more pronounced for firms with high levels of intangible investments.[9]

Agency theory

Central to agency theory is the proposition that in the presence of information asymmetry, managers may exploit their informational advantage by making decisions that further their self-interests rather than those of shareholders. Early studies on agency theory include Leland and Pyle (1977), Myers and Majluf (1984), Narayanan (1988) and Ross (1977). Following on the propositions of the agency theory, information asymmetry arises as managers (insiders) are better informed about the prospects of the firm than investors (outsiders). In this environment, which is characterised by an uneven distribution of information, firms use capital structure to signal their quality (signalling model) by adopting either a conservative or aggressive financing structure.

The agency theory posits that high quality and profitable firms commit to paying a high dividend or interest on debt as they are in a better position to avoid or manage the costs of bankruptcy. However, the ability of firms with bad prospects to mimic the information transmission mechanism of good firms, even if it might expose them to bankruptcy risks, results in the 'lemons problem in a market for used cars ' (see, Akerlof, 1970). This mimicking behaviour reduces the credibility of the signals as investors find it more difficult to distinguish between firms with good or bad prospects (see, Akerlof, 1970; Leland and Pyle, 1977). According to Myers (2003) agency theory also leads to hierarchical preferences of financing sources (as predicted by the pecking order theory).

It is reasonable to argue that since innovative firms are likely to be subject to rel-

[9] Several studies attribute IPOs underpricing to information asymmetry (e.g., Loughran and Ritter, 2002; Ritter, 1991; Ritter and Welch, 2002; Ritter, 2003).

atively higher levels of information asymmetry than for non-innovative firms, they are more likely to signal their quality by adopting conservative capital structures and commit to paying less dividends to retain a higher proportion of their earnings. These retained earnings are needed to finance R&D and further growth. According to O'Brien (2003), innovative firms are less reliant on debt as the covenants associated with debt financing may inadvertently restrict strategic flexibility that may harm innovation. The covenants can take the form of restrictions on further borrowings, expansion/investment and disclosure of information that may be proprietary. The need to maintain strategic flexibility by avoiding these restrictions should result in innovative firms adopting financing structures that differ from those of non-innovative firms.

Market timing theory

The market timing theory is premised on the proposition that managers time the issues or repurchases of debt and equity in order to take advantage of opportunities presented by changing capital market conditions (see, Alti, 2006; Baker and Wurgler, 2002; Dittmar and Thakor, 2007; Elliott et al., 2008; Jung et al., 1996; Heaton, 2002; Myers, 2003). Managers issue new equity when they perceive that it is overvalued and repurchase equity when it is perceived to be undervalued. Similarly, managers prefer debt financing in periods of undervaluation, and reduce debt in periods of overvaluation. According to Ljungqvist and Wilhelm (2003) managers defer issuing or repurchasing equity or debt if conditions are unfavourable.

The implication of market timing theory is that managers can affect firm value by strategically altering the financing mix to capture perceived mis-pricing. Baker and Wurgler (2002) argue that the current capital structure is a cumulative function of the past strategic attempts by managers to time equity markets. In line with the predictions of the market timing theory, Welch (2004) reports that the effects of changes in market prices remain persistent in a way that managers show no attempt at undoing the effects of changes in stock prices on capital structure. Similarly, Heaton (2002) also proposes the "windows of opportunity" and managerial optimism model to explain capital structure choices. The clustering of equity issues as firms seek to exploit higher prices and optimism in good times offers support to the market timing proposition (see, Campello and Graham, 2013; Ljungqvist and Wilhelm, 2003). A survey by Graham and Harvey (2001) report results consistent with the market timing proposition as the extent to which managers perceive the stock to be overvalued or undervalued influences financing decisions.

These results of the market timing theory suggest that the market timing behaviour is likely to be higher for innovative firms than for non-innovative firms because the former face higher levels of information asymmetry arising from their risky investments. Firms prone to high information asymmetry problems tend to "time the markets" by issuing (repurchase/redeem) overvalued (undervalued) securities in good (bad) times (Campello and Graham, 2013). This may result in innovative and non-innovative firms adopting divergent financing policies as financing and investment decisions are interdependent.[10] This thesis will extend the literature by examining how investment type (both fixed capital investments and R&D) may cause divergence in corporate financing decisions and how this overlooked interdependence changes over time.

Unified theory of capital structure

Relatively recently researchers started to consider the complementarity of the capital structure theories which had earlier divided scholars (see, Barclay and Smith, 1999; Beattie et al., 2006). Efforts to formulate a unified theory of corporate capital structure arise from the realisation that no extant theory on its own can fully explain the variations in capital structure (see, Frank and Goyal, 2009; Graham and Harvey, 2001; Myers, 1993; Oztekin, 2015). Carmen and Farhat (2009) report that the trade-off theory and the pecking order theory are not mutually exclusive. Similarly,

[10] Chava and Roberts (2008) and Stein (2003) highlight that despite the existence of a general consensus that financing activities and real decisions are interdependent in the presence of market imperfections, the exact nature of the relationship is subject to debate. Further, the results in the extant literature on the relationship between fixed capital investment and financing decisions are rather mixed (see, Dammon and Senbet, 1988) as Caglayan and Rashid (2014) and Lyandres and Zhdanov (2005) report a significant positive relationship while Aivazian et al. (2005), DeAngelo and Masulis (1980), Dang (2011) and Lang et al. (1996) report a significant negative relationship.

several studies conduct joint tests on the predictions of the theories. For example, Warr et al. (2012) in a joint test of the market timing theory and the trade-off theory report that equity mis-pricing has a significant effect on target financing behaviour, with over-levered firms adjusting faster when they have overvalued equity than undervalued equity. This result points to firms more susceptible to high information asymmetry problems, as the case with innovative firms, exploiting the mis-pricing of securities to more actively adjust capital structure towards the target. Further, as financial distress costs increase with both leverage and information asymmetry, innovative firms that may have high leverage will tend to adjust faster than those with low leverage and non-innovative firms.[11] The results in Chapter 5 confirm this prediction and suggests that investment type has a significant effect on target financing behaviour. This form of asymmetry that arises from investment type, that this thesis examines, is new to the literature and remains significant even after controlling for several other important determinants of capital structure.

Using a unified framework, Bonaimé et al. (2014) report that the value of adjusting leverage towards a target depends on equity mis-pricing, with firms that are undervalued and under-levered enjoy more economic benefits from using repurchases to adjust leverage. Similarly, Brav (2009), Shyam-Sunder and Myers (1999) and Lemmon and Zender (2010) report that firms with a financing deficit have a higher speed of adjustment than firms with a financing surplus. Joint tests of theories on capital structure can add new insights on financing decisions. However, Myers (2003) highlights that a unified theory is not feasible as the major theories are premised on often conflicting or opposing propositions. In contrast, Frank and Goyal (2007b) express optimism that attempts to unify the conflicting propositions of the trade-off theory, pecking order theory and market timing theory appear fruitful.

Overall, the predictions of the pecking order theory suggests that innovative firms

[11] According to a theory of Krainer (2014), firms use capital structure to manage the risks in their investment portfolio. This prediction suggests that firms with high risks should adopt conservative financing structures so as to reduce the overall risk of the firm to levels that are acceptable to their investors.

should be more reliant on internal financing sources than non-innovative firms. However, the internal financing sources may not be enough as innovative firms usually have high growth rates (as shown in Fig 3.3 of Chapter 3), which may result in them accessing external financing sources more often than non-innovative firms. Further, innovative firms may have more attractive investment opportunities that will enable them easily access external financing sources more easily (Fig 3.3 of Chapter 3 shows that, on average, innovative firms are more profitable than non-innovative firms). Although the market timing theory is premised on propositions that are different from those of the pecking order theory, it also suggests that innovative firms (high growth firms) should be more active in capital markets. Following on the predictions of the market timing theory, innovative firms are more likely to time the markets by issuing (repurchase) securities when they are over-valued (under-valued) as market timing behaviour increases with information asymmetry. In contrast to the predictions of the pecking order and market timing theories, the predictions of the trade-off theory suggests that innovative firms are likely to differ in terms of the target capital structure and how they adjust towards the target. The difference in the speed of adjustment arises may arise due to the fact that innovative firms are likely to face higher costs of deviating from the target than non-innovative firms would. This thesis will examine these theoretical predictions on the capital structure of innovative and non-innovative firms.

2.2.2 Empirical literature on capital structure

Most empirical studies focus on testing the propositions of the theories of capital structure (e.g., Frank and Goyal, 2009; Faulkender et al., 2008, 2012; Rajan and Zingales, 1995; Oztekin, 2015; Welch, 2004). This section presents a review of the determinants of financing structure and is used as a guide to our choice of variables that we use in the empirical analyses of Chapters 4 and 5. All the following variables will be used as core variables given that Chapter 4 focuses on the differences in the determinants of capital structure between innovative and non-innovative firms. In Chapter 5, the same variables will be used as control variables, except for, investment types, because the analysis is focused on differences in the target financing behaviour of innovative *versus* non-innovative firms.

Investment

Recent studies report that firms which access capital markets to fund large profitable investments also use that opportunity to adjust capital structure. For example, Dudley (2012) reports that lumpy investments provides an opportunity for firms in the US to adjust towards their optimal capital structure at lower marginal costs.[12] Similarly, Elsas and Florysiak (2013) find that firms in the US mostly use external sources to finance large investments and the issued securities move firms toward their target capital structure. However, several theories show that the impact of investment on leverage also depends on the nature of investments undertaken.[13]

The stakeholder co-investment theory, for example, posits that firms with unique products use less debt because they are more likely to face binding constraints (Titman, 1984). Following this prediction, firms investing in fixed capital use more debt financing (see, Lyandres and Zhdanov, 2005; Caglayan and Rashid, 2014), while firms investing in R&D use less debt (see, Dang et al., 2012; Flannery and Rangan, 2006; Faulkender et al., 2012). According to Frank and Goyal (2009), the negative relationship between debt and fixed capital investments is consistent with predictions of the pecking order theory that low issuance costs drive firms to use more equity financing. Similarly, Aivazian et al. (2005), Lang et al. (1996) and McConnell and Servaes (1995) report that firms use less debt so as to avoid or reduce underinvestment problems associated with debt overhang. However, the relationship between investment and leverage is not clear, with one strand of the literature (e.g., Aivazian et al., 2005; Dang, 2011; DeAngelo and Masulis, 1980; Lang et al., 1996) reports a negative rela-

[12]Further, Dudley (2012) finds that firms sequence equity before debt when raising external financing for large investments, as the tax benefits of debt will not be immediately realised given that most large projects take time to generate cash-flow. The preference to use equity over debt in financing lumpy projects is inconsistent with the predictions of the pecking order theory.

[13]Dudley (2012) uses an aggregate measure of lumpy investments that combines capital expenditure, R&D and changes in working capital. This approach tends to overlook the proposition that firms match financing sources to the asset structure (see, Campello and Giambona, 2013; Diamond and He, 2014; Myers, 1977; Ortiz-Molina and Phillips, 2014; Stein, 2003; Shleifer and Vishny, 1992).

tionship while another reports a positive relationship (e.g., Lyandres and Zhdanov, 2005; Rashid and Caglayan, 2012). Similarly, Mauer and Triantis (1994) report a insignificant relationship. These mixed results on the relationship between financing and investment decisions highlight the need for further research.[14]

Tangible assets

Firms with more tangible assets have greater collateral values with which to support further borrowing (see, Antoniou et al., 2008; Frank and Goyal, 2003, 2009; Oztekin, 2015; Titman and Wessels, 1988). Several studies report that collateral reduces moral hazard behaviour as the borrower stands to lose pledged assets if the borrower engages in opportunistic behaviour that is detrimental to the creditor (e.g., Acharya and Viswanathan, 2011; Berger et al., 2011; Norden and van Kampen, 2013; Rampini and Viswanathan, 2013). Recently, Campello et al. (2010), Campello et al. (2011b) and Kahle and Stulz (2013) report that firms used assets to alleviate the adverse effects of the recent global financial crisis. Campello et al. (2010) report that, in an attempt to avoid possible bankruptcy, financially constrained firms conducted fire sales of assets to generate liquidity. Similarly, Campello and Giambona (2013) find that firms with more redeployable assets (such as land, buildings, plant and equipment) are less likely to be credit constrained, especially during periods characterised by contractions in bank lending and decreases in economic growth. Also, Ortiz-Molina and Phillips (2014) find that firms with illiquid assets face binding financial constraints. Consistent with these theoretical predictions that collateral reduces information asymmetry problems, tangible assets is likely to exhibit a significant positive effect on leverage, with this effect being significantly higher for innovative firms that have less pledgeable assets.[15] This may result in innovative firms that also have high tangible assets being more able to access debt financing, since collateral reduces financial constraints. This thesis investigates whether the role of collateral in facilitating access to debt financing differs between innovative and non-

[14] Further, Stein (2003) highlights that although financing and investment decisions are interdependent (in contrast to the propositions of the MM Theory), the channels through which they relate remain unclear.

[15] See, Holmstrom and Tirole (1997), Leland and Pyle (1977), and Leland (1998).

innovative firms. This is carried out by comparing the coefficients on tangible assets between the two-firm groups.

Intangible assets

Intangible assets are increasingly becoming one of the most important assets on corporate balance sheets. Studies have overlooked the role of intangible assets in corporate financing decisions despite theoretical studies showing that contract incompleteness and limited enforceability subject firms to binding financial constraints (e.g., Hart and Moore, 1994; Holmstrom and Tirole, 1997). According to Aghion et al. (2004) and Brown et al. (2012) intangible investments are a poor form of collateral as they are more prone to information asymmetry, asset substitution and high specificity issues. However, it is rather important to note that firms with more intangible assets are surprisingly among the most geared (see Figure 3.2 in Chapter 3). The persistence of leverage against an increase in intangible assets is inconsistent with the literature (see, Aghion et al., 2004; Brown et al., 2012; Hall, 2002; Borisova and Brown, 2013), as this suggests that some firms with more intangible assets are still able to access debt financing. This evidence suggests that intangible assets support debt financing, which is inconsistent with the theoretical predictions of Hart and Moore (1994) and Holmstrom and Tirole (1997). This thesis will examine the effects of intangible assets of capital structure and whether this effect differs between innovative and non-innovative firms. As innovative firms have more intangible assets, their effect on leverage is likely to be higher, and perhaps increasingly so, with the increasing rate of transition of economies towards service and technological sectors.

Growth

There is an ongoing debate on the effect of growth on capital structure. According to the predictions of the trade-off theory, firms with more growth opportunities use less debt financing to preserve flexibility (Frank and Goyal, 2009; Oztekin, 2015). This results in a negative effect of growth on debt (see, Graham and Leary, 2011; Rajan and Zingales, 1995; Ozkan, 2001; Wu and Au Yeung, 2012). High growth firms use less debt to signal to the market that they do not under-invest or engage in asset substitution (Drobetz and Wanzenried, 2006). However, the need for high-growth firms to regularly access capital markets implies that growth has a positive effect on debt financing (see, Dang et al., 2012; Dang, 2013a; Dang et al., 2014a; Drobetz and Wanzenried, 2006). According to Frank and Goyal (2009), the observed high market-to-book ratios may be due to mis-pricing, which tends increase the possibility of market timing. If innovative firms are more likely to engage in market timing relative to non-innovative firms, then, their high market-to-book ratios (high growth) would result in a decrease in leverage (implying a negative relationship) as they issue more overvalued equity. This prediction suggests that the role of market-to-book ratios in financing decisions, which is examined in this thesis, may differ significantly between innovative and non-innovative firms.

Size

Size is positively related to leverage as the risk of bankruptcy decreases with firm size (see, Elsas et al., 2013; Faulkender et al., 2008, 2012; Frank and Goyal, 2009; Leary and Roberts, 2005; Oztekin, 2015; Rajan and Zingales, 1995). Similarly, Strebulaev and Kurshev (2006) report that large firms have well established relationships with lenders, which implies that they face low financial constraints than small firms. According to Drobetz and Wanzenried (2006) and Vincent and Michaely (2012) information asymmetry and agency problems decrease with firm size since large firms are closely followed by investors and analysts. The high reputation, low information asymmetry, and agency issues of large firms allow them to access capital markets more easily, which results in a positive relation between size and debt financing. According to Titman and Wessels (1988) larger firms are able to borrow at relatively lower costs since they are more diversified than smaller firms.

The importance of size as a determinant of capital structure is decreasing overtime and mostly in countries with weak institutional frameworks (Oztekin, 2015). Similarly, Graham et al. (2015) report that the relationship between size and leverage is affected by the increase in small firms in the US over the past century. In a cross-country study, Frank and Goyal (2009)'s literature review on the most reliable determinants of capital structure shows that the effect of size on leverage is more important for firms with low market-to-book ratios than those with high market-to-book ratios. This should result in a lower effect of size on debt for innovative than non-innovative firms. However, this is in contrast to the pecking order theory which predicts a negative relationship between leverage and firm size as large firms are better positioned to issue equity and reduce debt financing (Frank and Goyal, 2009). This also shows the mixed results on the effect of size of debt even though most studies report a positive relationship. This thesis examines the differential effect of size on capital structure of innovative and non-innovative firms. Size is likely to have a higher positive effect on the capital structure of innovative firms with high information asymmetry, asset substitution problems, long investment horizons and low collateral values due to high specificity. All these characteristics may subject innovative firms to binding financing constraints relative to non-innovative firms.

Profitability

Reported evidence on the effect of profitability on leverage is rather mixed.[16] Goyal and Wang (2011), Liu (2009), Rajan and Zingales (1995), Oztekin (2015) and Warr et al. (2012) report a negative effect of profitability on debt financing as is consistent with the pecking order theory which posits that internal financing is preferred to external financing. Profitable firms have more retained earnings with which to finance further investments and pay-off outstanding debt (see, Antoniou et al., 2008; Oztekin and Flannery, 2012). Firms may prefer equity because the use of debt reduces strategic flexibility and requires greater transparency, which may inadvertently reveal proprietary information to rivals (see, O'Brien, 2003). This may result in firms with innovative investments adopting conservative financing structures even though their profitability encourages the use of high levels of debt financing. In an attempt to avoid the restrictions associated with debt financing, firms use internal sources and access external capital markets only when retained earnings are exhausted (Myers, 1984; Myers and Majluf, 1984). However, other empirical studies report a positive

[16] Chen and Zhao (2005) and Strebulaev (2007) show that the channels through which profits and leverage relates are unclear and complex.

effect of profitability on debt, as is consistent with the trade-off theory (Jensen et al., 1992).

Agency theory predicts a positive relationship as the disciplinary role of debt in curbing the abuse of free cash flow is more valuable for profitable firms which generate free cash flows (see, Easterbrook, 1984; Jensen and Meckling, 1976; Jensen, 1986). Similarly, the signalling hypothesis of Ross (1977) implies a positive relation as firms use debt to signal their quality in the form of a commitment to pay a large proportion of earnings (interest on debt) to creditors. Frank and Goyal (2009)'s review shows that the importance of profitability as a determinant of capital structure is decreasing over time, which is consistent with the increasing willingness to finance unprofitable investments with good long-term prospects.[17] Following on these studies, profitable firms are likely to use less external financing (in particular, debt) as they can satisfy most of their financing needs using internally generated funds. In line with this prediction, Fig 3.3 of Chapter 3 shows that over time innovative firms are more profitable than non-innovative firms. This should result in a relatively high negative effect of profitability on debt for innovative firms relative to non-innovative firms. However, as innovative firms are mostly high-growth firms, they may use their high profitability (in case they generate high profits) to access further debt financing. These opposing predictions highlight that the effects of profitability on debt financing is rather unclear for both innovative and non-innovative firms. This is investigated further in this thesis.

Non-debt tax shield (NDTS)

The results on the effects of the non-debt tax shield on leverage is similarly mixed. The non-debt tax shield is negatively related to leverage as it is a substitute for tax shields of debt financing (see, Dang et al., 2012, 2014a; DeAngelo and Masulis, 1980). Similarly, Leary and Roberts (2005) and de Miguel and Pindado (2001) report a negative effect of the non-debt tax shield on leverage. However, other studies report a

[17] Similarly, Fama and French (2004), Fama and French (2005) and Frank and Goyal (2003) report marked increase in issuing activities of small and financially weaker firms.

positive effect (Antoniou et al., 2008; Frank and Goyal, 2009; Titman and Wessels, 1988), which is inconsistent with the substitution proposition of DeAngelo and Masulis (1980). Titman and Wessels (1988) attribute the change in the coefficient of the non-debt tax shield to differences in the way in which this shield is measured, with a negative coefficient observed if the measure of the shield is scaled by total assets while a positive coefficient is observed if the measure is scaled by operating income or sales. This thesis examines whether the lower proportion of fixed assets on corporate balance sheets of innovative firms (as shown in Fig 3.3 of Chapter 3) should result in a lower effect of non-debt tax shield on their capital structure decisions relative to non-innovative firms.

Volatility

Firms with volatile earnings are more risky and have higher bankruptcy costs, which leads them to use less debt (Fama and French, 2002). Similarly, volatile earnings subjects firms to binding financial constraints (Antoniou et al., 2008; Dang et al., 2012, 2014a). According to studies in the US by Campello et al. (2010) and Cook and Tang (2010) risk increase in bad macroeconomic environments further exacerbate credit constraints for firms with volatile earnings. Brown et al. (2012), Hall (1992) and Hall (2009) report that firms with intangible investments use equity financing to offset the high risk in their investment portfolios. Similarly, Dierker et al. (2013) report that firms adjust capital structure to manage risk. The low leverage of firms with risky investments is consistent with the trade-off theory which posits that firms balance the benefits and costs of debt when deciding on the optimal capital structure. Recently, Krainer (2014) develops a model in which managers use capital structure to manage operating risk to levels commensurate with the risk appetite of the investors. The high volatility of earnings of firms that invest in innovation (see, Brown et al., 2012; Dang, 2011; Hall, 2009) should result in innovative firms adopting conservative financing structures relative to non-innovative firms. In this thesis, comparisons based on cross-sections and time variations are drawn on the effect of volatility on capital structure for innovative and non-innovative firms.

Overall, the mixed results on the determinants of capital structure highlight the need for further research. In particular, the unclear relationship between leverage and investment (see, Chava and Roberts, 2008; Stein, 2003) suggests the need for a study of how investment type (innovative and non-innovative investments) affects financing decisions. Further, the extant literature investigates mostly capital expenditure and overlooks the marked increase in intangible investments.[18] It also largely ignores the fact that different types of corporate investment often compete for the same financing sources (interdependence).

The following section presents a review of the theories and determinants of trade credit.

2.3 Trade credit: Literature review

This section presents a review of the literature on trade credit. There are four major propositions on trade credit: (i) comparative advantages in borrowing, (ii) informational advantages and control over the buyer, (iii) price discrimination, and (iv) transaction costs and warranty on quality. Literature relevant to each of these propositions is review in turn next.

2.3.1 Trade credit theories

Comparative advantages in borrowing

Suppliers of goods have a comparative advantage in evaluating the creditworthiness and enforcing credit contracts over traditional lenders in the presence of information asymmetry (see, Cuñat, 2007; Petersen and Rajan, 1997). Suppliers may borrow from lending institutions at comparatively better terms than their customers and, in turn, advance credit to financially constrained customers. Frank and Maksimovic (2005) and Mian and Smith (1992) report that suppliers have a comparative advantage in liquidating the repossessed inventory if a buyer fails to settle since they already have

[18] Several studies in the US report marked increases in R&D over the past decades (e.g., Borisova and Brown, 2013; Brown and Petersen, 2011; Falato et al., 2013; Sporleder et al., 2002).

an established network to sell the repossessed goods. Similarly, Frank and Maksimovic (2005) report that suppliers have advantages in salvaging value from repossessed goods. The comparative advantages in borrowing are likely to be greater for non-innovative firms with more pleadgeble assets relative to innovative firms that invest mostly in intangible assets. This prediction, which is examined in this thesis, should result in non-innovative firms giving (using) more (less) trade credit than innovative firms.

Informational advantages and control over the buyer

According to Emery (1984) and Jain (2001) informational advantages arise as the supplier has regular access to the buyer. The timing and size of the orders placed by customers reveal important information about the credit quality of the buyer (Biais and Gollier, 1997; Brennan et al., 1988; Smith, 1987). According to Petersen and Rajan (1997) the supplier has greater control over the buyer if the supplier is large and the products supplied are specialised. This reduces the incentive for the buyer to default as the buyer has limited alternatives. Petersen and Rajan (1997) report that this influence is not available to other creditors such banks. Biais and Gollier (1997) present a model in which firms are unable to secure lending from banks unless the bank observes that the firm is able to get credit from its suppliers. The ability to secure credit from suppliers who are better informed than lending institutions about the buyer acts as a credible signal on the prospects of the borrower. The informational advantages and control over the buyer hypothesis posits that firms with unique products, like innovative firms, may be more willing to give credit to their customers (Biais and Gollier, 1997; Brennan et al., 1988; Smith, 1987).[19] Consistent with this hypothesis, Stroebel (2015) presents a model showing that non-integrated lenders charge comparatively higher interest rates than integrated lenders to compensate for the high information asymmetry in collateral values. Cuñat (2007) and Petersen and Rajan (1997) highlight that firms with unique products (such as innovative firms) may have a comparative advantage in the quantity and quality of

[19] This should result in innovative firms giving relatively more trade credit to their customers as they have comparative advantages in evaluating the credit quality of their customers for innovative products.

information collected on the credit worthiness of their customers. This would suggest that innovative firms may be able to provide relatively more trade credit than non-innovative firms. In fact, this is confirmed in our sample of UK firms as shown in Figure 3.4 of Chapter 3. This prediction is formally tested in Chapter 6 by examining the difference in the determinants of trade credit for innovative and non-innovative firms.

Price discrimination

Since by law firms are precluded from engaging in price discrimination, the ability to combine credit with the goods helps in overcoming this restriction. Meltzer (1960) and Petersen and Rajan (1997) report that a supplier may be able to charge higher prices to risky customers by offering them trade credit, while at the same time offering low prices through discounts to credit worthy customers and for early payments. Petersen and Rajan (1997) highlight that financially constrained customers may find it worthwhile to borrow using trade credit as it may still be relatively cheaper and easier to access than other types of loans. These predictions are in contrast to Lin and Chou (2015) who report that trade credit is relatively more expensive than bank loans. In line with the price discrimination hypothesis, Fig 3.4 of Chapter 3 shows that innovative firms in our sample give more trade credit than non-innovative firms, which suggests that they are more likely to discriminate using trade credit as they sell risky products that may have low re-saleable values (in case of repossessions).

Transaction costs and warranty on quality

Specialised goods require a warranty from the supplier. The provision of trade credit is a form of warranty on the quality of the goods as it allows the buyer to try the goods before paying for them. Long et al. (1993) report that if trade credit is used as a form of guarantee for product quality, then large and more established firms with reputable products, need not offer trade credit. Elliehausen and Wolken (1993), Ferris (1981) and Wilson and Summers (2002) highlight that trade credit can reduce the need to hold precautionary cash balances (by reducing transaction costs) in the presence of uncertainty about production needs and delivery times. Petersen and

Rajan (1997) report that trade credit may also help to reduce transaction costs as buyers can accumulate obligations and discharge them later instead of paying for every transaction. According to Emery (1987) trade credit can be used to reduce storage or warehousing costs as it facilitates early sales of seasonal products. Since innovative products require more warranties than non-innovative ones, this should result in innovative firms giving their customers more credit than non-innovative firms.[20]

2.3.2 Determinants of trade credit

This section presents a review of the empirical results on the determinants of trade credit. Although the literature identifies a core set of factors that determine trade credit, the results are mixed and do not address whether trade credit policies of innovative firms differ from those of non-innovative firms.[21] This guides our choice of control and other variables that we use in the empirical analyses of Chapter 6 focusing on the differences in trade credit and its determinants. All of the following are used as control variables , except for short-term debt and cash that are the core variables for the analyses in Chapter 3.

Short-term debt

There is an ongoing debate on the relationship between short-term debt and trade credit. Guariglia and Mateut (2013) and Kling et al. (2014) report that short-term debt and trade credit are compliments rather than substitutes. However, the substitution hypothesis predicts a negative relationship between short-term debt and trade credit. According to Meltzer (1960) and Wilner (2000) firms with access to other forms of financing use these to substitute the relatively expensive trade credit. Mateut et al. (2006) and Yang (2011b) report that the relationship between short-term debt and trade credit changes with monetary policy. Yang (2011b) find that short-term debt and trade credit are compliments under a loose monetary policy regime and substi-

[20](Fig 3.4 of Chapter 3 consistently show that innovative firms give (use) more (less) trade credit than non-innovative firms.

[21]For a review of the determinants of trade credit, see Bastos and Pindado (2013), Bougheas et al. (2009), Klapper et al. (2012), Kling et al. (2014), Long et al. (1993), Love (2003), Mateut et al. (2006), Murfin and Njoroge (2015), Nilsen (2002), Petersen and Rajan (1997) and Wu et al. (2012).

tutes under a tight regime. These changes show that it is not *a priori* clear whether the complementary or substitution effect predominate the relationship between trade credit and short-term debt, more so, between innovative and non-innovative firms. Further, firms that face binding financial constraints are more likely to rely on trade credit as a form of financing, which suggests that short-term debt and trade credit are compliments rather than substitutes for innovative firms. Theories of Diamond (1991) and Hart and Moore (1994) posits that firms match the maturity of assets to financing sources, which suggests that innovative firms with longer investment horizons are less likely to rely on short-term debt and trade credit financing. Following on these mixed predictions, this thesis will examine in Chapter 6 the differences between innovative and non-innovative firms in the relationship between short-term debt and trade credit, and how this relationship changes over time. Although the literature examines the relationship between short-term debt and trade credit, the time variations and differences between innovative and non-innovative firms that we examine in this thesis have been overlooked in prior studies (see, Guariglia and Mateut, 2013; Kling et al., 2014; Meltzer, 1960; Wilner, 2000).

Cash

There is an ongoing debate on the effect of cash on trade credit. Petersen and Rajan (1997) report that cash has no empirical effect on trade credit. However, Dass et al. (2014) and Wu et al. (2012) report that cash has a negative effect trade credit. Similarly, Bougheas et al. (2009) find a negative effect of cash on trade credit amongst private firms in the UK. Innovative firms are less likely to use excess cash to reduce accounts payable as they would rather hoard cash to finance future investments and to cushion against adverse supply shocks in capital markets. Similarly, Acharya et al. (2007), Acharya et al. (2012), Ang and Smedema (2011) and Bates et al. (2009) report secular increases in cash holdings in the US and attribute this to the growing need to increase corporate flexibility. As corporate flexibility is more important for innovation, this suggests that innovative firms are less likely to use cash to reduce trade credit they may have taken. This prediction is also consistent with O'Brien (2003) who report that maintaining flexibility is critical for survival in highly competitive innovative product markets. However, the reverse applies for account receivables, as innovative firms are more likely to use cash to increase the credit they extend to their customers relative to non-innovative firms. The informational advantages and control over the buyer propositions suggest that innovative firms are likely to extend more trade credit than non-innovative firms (Emery, 1984; Jain, 2001). This suggests that cash will have a relatively more significant positive effect on accounts receivable of innovative than non-innovative firms. However, the stability of cash in UK firms over time shows no clear relationship with trade credit (Chapter 3). Further, the relationship between trade credit and cash is a subject of an ongoing debate. This thesis examines the relation, and how it may differ and change over time between innovative and non-innovative firms. The time variations, though important (as shown by results in Chapter 6), have been not been examined in the literature, which focus mostly on cross-sectional differences.

Tangible assets

Firms with more tangibles assets have more access to other sources of financing and can in-turn give more trade credit to their customers. According to Campello and Giambona (2013) firms with deployable real assets are likely to face low credit constraints, hence, will use less trade credit. Consistent with the comparative advantage in borrowing proposition, Bastos and Pindado (2013), Garcia-Appendini and Montoriol-Garriga (2013), Giannetti et al. (2011) and Guariglia and Mateut (2013) report a negative effect of tangible assets on trade credit. If firms have access to alternative sources of financing, they use less trade credit as it is relatively expensive (see, Petersen and Rajan, 1994, 1995). This prediction suggests that innovative firms, with less tangible assets, are more likely to use trade credit than non-innovative firms. However, the unreliability of trade credit may discourage firms from using it as it tends to decrease when is needed most during contractions in bank lending (such as during the recent global financial crisis). Further, firms match the maturity of assets with that of financing, which suggests that innovative firms with longer investment horizons use less trade credit. This thesis examines how the effect of tangible assets on trade credit may differ for innovative and non-innovative firms.

Intangible assets

The growing importance of intangible assets on corporate balance sheets has been overlooked by researchers.[22] As intangible assets are poor candidates for collateral, firms with more intangible assets are prone to problems of information asymmetry, asset substitution and high specificity which limit their ability to access borrowing (Brown et al., 2012). However, Lim et al. (2014) report that intangible assets, reported in the purchase price allocation data of the bidding firms' 10-Ks or 10-Qs, support debt financing. Also, firms with innovative investments are able to borrow at better terms than traditional firms (Hall, 2009). Therefore, the effect of intangible assets on trade credit is *a priori* clear.

Size

Firm size is associated with greater ability to extend trade credit to customers as larger firms can borrow at competitive rates.[23] Also, larger firms may offer more trade credit as they have low credit risk and higher bargaining power (Petersen and Rajan, 1997). However, with easier access to more favourable forms of financing, larger firms may rely less on trade credit. Bastos and Pindado (2013), Garcia-Appendini and Montoriol-Garriga (2013), Giannetti et al. (2011) and Guariglia and Mateut (2013) report that size is positively associated with trade credit. Lin and Chou (2015) report mixed effects of size on trade credit. This thesis examines these mixed results, and how the effect of size on trade credit may differ between innovative and non-innovative firms, with the former being generally smaller and likely more credit constrained than the latter.

[22] Studies have overlooked the role of intangible assets in corporate financing decisions despite theoretical predictions from models by Hart and Moore (1994) and Holmstrom and Tirole (1997) showing that contract incompleteness and limited enforceability of intangible assets subject firms to binding financial constraints.

[23] Studies on capital structure report that size is positively related to leverage as the risk of bankruptcy tends to decrease with the growth in a firm's assets (e.g., Elsas et al., 2013; Faulkender et al., 2008, 2012; Frank and Goyal, 2009; Leary and Roberts, 2005; Rajan and Zingales, 1995; Oztekin, 2015).

Profit

Profitable firms have more internal sources and easier access to capital markets, which enables them to extend more trade credit to their customers.[24] Consistent with this proposition, Garcia-Appendini and Montoriol-Garriga (2013) and Giannetti et al. (2011) report that profit is negatively related to trade credit. However, more profitable firms are good candidates for credit from suppliers, which implies a positive relationship between profit and trade credit. Similarly, a study of Chinese firms over the period 2000-2007 by Guariglia and Mateut (2013) reports mixed effects of profit on trade credit. Furthermore, profitable firms are better positioned to advance credit to their customers. This prediction, which is examined in this thesis, suggests that innovative firms may give (use) more (less) trade credit than than non-innovative firms.

Asset turnover

Firms can increase turnover through credit sales. This results in a positive relationship between asset turnover and trade credit. However, a study of firms in Argentina, Brazil, and Turkey by Bastos and Pindado (2013) reports that asset turnover has a insignificant effect on trade credit. They attribute this to an increase in total assets arising from an increase in debtors which then reduce asset turnover ratios. The overall effect of asset turnover on trade credit is ambiguous as it depends on which effect predominates. Asset turnover is likely to be higher for innovative than non-innovative firms as they have relatively more intangible assets. This high asset turnover for innovative firms may result in a relatively more significant positive effect of asset turnover on trade credit policies of innovative firms relative to non-innovative firms. As the results in Chapter 3 show that trade credit and asset turnover are all decreasing over time, with this decrease being relatively higher for innovative than non-innovative firms, the relationship is becoming rather unclear, particularly over time and between innovative and non-innovative firms.

Volatility

[24] A model of Schwartz (1974) show that suppliers with easy access to capital markets find giving trade credit more attractive.

Firms with volatile earnings use less debt as they are considered more risky and have high bankruptcy costs (e.g., Antoniou et al., 2008; Dang et al., 2012, 2014a; Fama and French, 2002). Giannetti et al. (2011) report a negative effect of credit risk on trade credit. This evidence implies that firms with more volatile earnings should use less trade credit. However, financially constrained firms may use more trade credit as this presents them with an opportunity to extract large concessions from suppliers in case of bankruptcy (see, Evans, 1998; Wilner, 2000). Petersen and Rajan (1994, 1995, 1997) and Wilner (1997) report that financially constrained firms are amongst the most frequent users of trade credit. A positive effect of volatility on trade credit may also result if high risk in operating earnings limits access to other alternative forms of financing. Consistent with this proposition, Bastos and Pindado (2013) report a positive relationship between probability of insolvency and trade credit. This prediction suggests that innovative firms may use more trade credit than non-innovative firms. However, as firms match the maturity of assets to financing sources (see, Diamond, 1991; Hart and Moore, 1995) and want to maintain strategic flexibility (see, O'Brien, 2003), innovative firms with longer investment horizons and irreversible investments should use less trade credit financing. This thesis investigates these two opposing predictions on the relationship between volatility and trade credit by comparing the effect of volatility on trade credit policies of innovative and non-innovative firms.

Overall, the mixed results on the determinants of trade credit also highlight the need for further research, particularly, in relation to the overlooked differences between innovative and non-innovative firms. There is a need to examine why trade credit is decreasing over time. Examining the changes in corporate policies, such as trade credit, arising from different types of corporate investment is increasingly becoming important as economies transit from manufacturing towards service and technology sectors.

2.4 Summary

The review of the literature in this chapter highlight a lack of consensus on the determinants of financing and trade credit policies. Several hypotheses have been put forward in an attempt to explain the observed variations in financing structure (trade-off theory, pecking order theory, agency theory and market timing theory). The existence of these propositions that try to explain the same phenomena makes it difficult to achieve consensus with scholars divided along the lines of the major theories on corporate financing decisions. This thesis represent an attempt to fill some of the gaps in the literature, in particular, on how investment types influence financing and trade credit decisions, using sample of firms in the UK (in country analysis) given the concentration of studies to the US (which limits generalisation of results to other economies) and mixed results from previous large cross-country studies. The literature motivating the research in each of the empirical chapters (Chapter 4, 5 and 6) is discussed further in the following chapters as each investigates a specific aspect of corporate financing decisions.

Chapter 3

Data and Methodology

3.1 Introduction

This chapter presents the data and methodology used in the following three empirical chapters. The rest of this chapter is organised as follows: Section 3.2 presents the sample screening process, Section 3.2.1 presents the sample composition, Section 3.3 presents the variable definitions, and Section 3.5 presents an overview of the methodology used.

3.2 Sample screening

The data on all variables is drawn from Worldscope through Datastream. The initial sample consists of 296,044 firm-year observations (10,573 firms) of all firms listed on the main official list of the London Stock Exchange (LSE) over the period 1987-2013. Prior periods have limited observations on key variables to facilitate meaningful analysis.[1]

As is standard in the literature, a number of filters (screens) are applied to the data. First, the sample is restricted to 1,754 firms (49,112 firm-year observations) excluding firms in the financial and utility sectors, as their operating and regulatory environments have significant effects on corporate decisions.[2] Fama and French (2002), Frank and Goyal (2009), Korajczyk and Levy (2003) and Oztekin (2015) apply a similar approach. Brav (2009) argues that this restriction allows for a more focused analysis of companies with business structures that are most relevant to capital structure theories. Second, firms with missing data on total debt, sales and total assets are excluded (37,107 firm-year observations).[3] Third, consistent with Dudley (2012), missing values for the research and development (R&D) variable are set to zero (40,702 firm-year observations).

Fourth, in order to control for mergers and acquisitions, 475 firm-year observations

[1] Further, the reporting of R&D only became compulsory in 1989.

[2] The exclusion of the financial and utility sectors allows for direct comparisons with prior studies on capital structure (e.g., Aghion et al., 2004; Brav, 2009; Dudley, 2012).

[3] Akbar et al. (2013), Lemmon and Roberts (2010) and Sufi (2009) use a similar criterion to deal with problems of missing data.

with changes in total assets, employees or sales in excess of 100% are excluded (Bloom et al., 2007; Dudley, 2012).[4] Fifth, firms with less than five years of observations are excluded (3,134 observations) as the system Generalised Method of Moments (system GMM thereon) used in the analyses in this thesis requires the use of lagged variables as instruments (Baum et al., 2013; Banos-Caballero et al., 2013). Sixth, all variables used are winsorised at the lower and upper one percentile of the distribution in each year to address the compounding effects of outliers and conserve sample size.[5] Finally, de-listed or suspended firms (254 observations) are retained in the final sample in order to ameliorate survivorship bias. Due to missing data, entry and exit as well as the application of the above filters, the final sample consists of 8,396 firm-year observations (817 firms), over the period 1987 to 2013. Data unavailability and the need to use lagged variables as instruments for endogenous variables represent the main restrictions on the sample size and period.

3.2.1 Sample composition

Table 3.1 presents the sample composition. Panel A presents the distribution of the sample across industries. Panel B presents the distribution of the sample by age which is defined as the difference between the current year being examined and the year the company first appeared in Datastream. Panel A shows that innovative firms constitute the majority of the 8, 396 firms (61%), while non-innovative firms account for 39% (3,304) of the total firms in the sample. This shows that an high proportion of firms in the UK are undertaking innovative investments, which is similar to results in the US (see, Damodaran, 1999, 2009; Lim et al., 2014). The main drawback of focusing on listed firms is that most innovative investments are undertaken by private firms, many of which do not go public either due to them opting to remain private or going out of business. The limitations to the studies in this thesis are discussed further in Chapter 7.

[4]Using 125% cut-off to eliminate mergers and acquisitions or unusual changes in firm size as applied by Dudley (2012) does not change the results significantly.

[5]Dang et al. (2014a) and Flannery and Rangan (2006) use a similar approach to address the effects of outliers. The alternative to dealing with outliers involves excluding or deleting observations identified as outliers from the final sample. This would greatly reduce the sample size.

Table 3.1 Sample composition

The table presents the distribution of the sample by industry and age. The table reports the proportion of firms in each industry and age group. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK from the main official list of the London Stock Exchange over the period from 1987 to 2013. All variables used are defined in Table 3.2. The data is drawn from Worldscope through Datastream.

Panel A: Industrial distribution

Industry	ALL	NIN	INN	Frequency (%)
Total	8396	3304	5092	100.0%
Frequency (%)	100.0%	39.4%	60.6%	

Panel B: Sample structure

Age (years)	Firms	Firm-year observations	Frequency (%)	Cumulative frequency (%)
5	131	655	8%	8%
6	97	582	7%	15%
7	79	553	7%	21%
8	75	600	7%	28%
9	80	720	9%	37%
10	65	650	8%	45%
11	50	550	7%	51%
12	34	408	5%	56%
13	45	585	7%	63%
14	22	308	4%	67%
15	19	285	3%	70%
16	21	336	4%	74%
17	12	204	2%	77%
18	13	234	3%	79%
19	12	228	3%	82%
20	8	160	2%	84%
21	6	126	2%	86%
22	10	220	3%	88%
23	3	69	1%	89%
24	3	72	1%	90%
25	4	100	1%	91%
26	5	130	2%	93%
27	23	621	7%	100%

Consistent with studies on the US, the 51% of the firms in Panel B of Table 3.1 have a life below 11 years.[6] This short life span of firms suggests that studies focusing on shorter periods tend to overlook the impact of changes in firm composition on corporate decisions. This thesis accounts for the effects of changes in firm composition on corporate decisions by examining capital structure decisions of firms in the UK over a relatively longer period and also, using sub-period analyses. Studies on the UK are restricted to annual data, whereas data on US company accounts is available at quarterly intervals. Also, data limitations on UK company accounts reduces the sample period since some account items are unavailable prior to 1989.[7] However,

[6] Dang et al. (2012, 2014a), and Flannery and Hankins (2013) report that the average life of firms in the US is less than 10 years.

[7] Appendix 3.A presents a sample decomposition by year. It shows that there are more firm-year observations during the period from 1989 to 1999. The high concentration of the firm-year observations in the 1990s is partly attributed to the entry of young growth firms prior to the tech-bubble.

the focus on a relatively long period as adopted in this study may also be subject to survivorship bias.[8]

3.3 Variable definitions

This section presents definitions of the variables used. Table 3.2 presents the variables and the account items. The Datastream code of which is reported in parenthesis. The account items were obtained from Datastream. All variables, except size and earning volatility, are divided by total assets to reduce scaling effects. Size is defined as the natural logarithm of total assets, and earnings volatility is defined as the three-year-moving standard deviation of profits. The adopted definitions are standard in the literature on capital structure.[9]

3.3.1 Dependent variables

This section presents the construction of the dependent variables and discusses the literature motivating the choice of the dependent variables used in this thesis.

Leverage

There is considerable debate on the most appropriate measure of leverage, with Barclay et al. (2006), Fama and French (2002) and Graham and Harvey (2001) preferring book-based measures, while Dang et al. (2012), Frank and Goyal (2007a) and Welch (2004) preferring market-based measures. Barclay et al. (2006) highlight that there is no particular economic reason to expect the same results from studies that adopt market-based and book-based measures of leverage. Rajan and Zingales (1995) highlight that the appropriate measure of leverage depends largely on the objectives of the study. Similarly, Bessler et al. (2011), Graham and Harvey (2001) and Stonehill et al. (1975) report that managers base their decisions on book-based measures

Consistent with this, Fama and French (2004) report an influx of young firms conducting initial public offerings (IPOs) in the US from 1980 to 2001.

[8] This problem is addressed in this thesis by using a combination of sub-period and time variation analyses. According to Welch (2011), survivorship bias is difficult to correct and most studies assume that the population of firms is fairly constant.

[9] Several studies on capital structure use similar variable definitions (e.g., Flannery and Rangan, 2006; Goyal et al., 2011; Oztekin, 2015).

Table 3.2 Variable definitions

The table lists the definitions of all variables used and the account items obtained from Datastream (in parenthesis). The data is drawn from Worldscope through Datastream.

Variable	Acronyms	Definition
Total liabilities	TLTA	Total liabilities (WC03351) scaled by total assets (WC02999).
Equity		Total liabilities & shareholder equity (WC03255) less total liabilities (WC03351).
Total debt	TDA	Total debt (WC03255) scaled by total assets (WC02999).
net-debt	NDA	Total debt (WC03255) less cash & cash equivalent (WC02005) scaled by total assets (WC02999).
Long-term debt	LTDA	Long-term debt (WC03251) scaled by total assets (WC02999).
Short-term debt	STDA	Short-term debt (WC03051) scaled by total assets (WC02999).
Accounts payable	AP	Trade Creditors (WC03040) scaled by total assets (WC02999).
Accounts receivable	AR	Trade Debtors (WC02051) scaled by total assets (WC02999).
Net trade credit	NTC	Debtors (WC02051) less creditors (WC03040), scaled by total assets (WC02999).
R&D Dummy	*RDD*	Dummy variable taking the value of one if R&D is positive and zero otherwise.
Research & Development	R&D	Research & development expenditure (WC01201) scaled by total assets (WC02999).
Capital expenditure	Capex	Capital expenditure (DWCX) scaled by total assets (WC02999).
Working Capital	WC	Current Assets (WC02201) less Current Liabilities (WC02005) scaled by total assets (WC02999).
Investment	Invest	Capital expenditure (DWCX) plus research & development expenditure (WC01201) plus changes in Working Capital, all scaled by total assets (WC02999).
Other short-term liabilities	Ostliab	Current liabilities (WC02005) less creditors (WC03040) to total assets (WC02999).
Cash		Cash and cash equivalent (WC02005) to total assets (WC02999).
Growth		Market capitalisation (WC08001) plus total liabilities (WC03351), scaled by total assets (WC02999).
Tangible assets	Tangible	Fixed assets (W02501) scaled by total assets (WC02999).
Intangible assets	Intangible	Intangible assets (WC02649) scaled by total assets (WC02999).
Size		The logarithm of total assets (WC02999) in 2000 prices.
Profit		Earnings Before Interest & Tax (EBIT) (WC18198) scaled by total assets (WC02999).
Non debt-tax shields	NDTS	Depreciation (WC01151) to total assets (WC02999).
Earnings volatility	Volatility	Three year moving standard deviation of profits (WC18198).
Asset turnover	AssetTurn	Total assets (WC02999) scaled by sales (WC07240).
Equity issues		5% increase in equity less total liabilities (WC03351)) scaled by total assets (WC02999).
Debt issues		5% increase in equity (WC03255) scaled by total assets (WC02999).
Equity repurchases		5% decrease in equity scaled by total assets (WC02999).
Debt retirements		5% decrease in equity (WC03255) scaled by total assets (WC02999).
Deviation	DEV	Target leverage minus actual lagged leverage.
Age		The difference between the current year and the first reporting year for the company (WC05350)
Sales growth		Year on year growth in sales (WC07240).
Dividend pay-out	Dividend	Dividends (WC18192) scaled by total assets (WC02999).

rather than market-based measures of capital structure. Since the focus of the analyses in this thesis is on the changes in capital structure arising from decisions taken by managers, book-based measures are deemed more appropriate as they are less influenced by changes or events unrelated to the firm.

Beside the debate on book *versus* market-based measures, there is also a debate on which components of leverage (total liabilities, total debt, net-debt or long-term debt) should studies focus on. In light of the debate on the components of leverage and the mixed results in the literature, this thesis adopts a decompositional approach that focuses on four main components of leverage, namely, total debt, net-debt, long-term debt and total liabilities.[10] The main advantage of this approach is that it allows for a more comprehensive analysis of compositional changes in leverage over time. Welch (2004) highlights that although leverage may be relatively stable in aggregate, as Lemmon et al. (2008) and Hanousek and Shamshur (2011) report, the components of leverage exhibit greater variability. DeAngelo and Roll (2015) report similar variations in leverage in the US and conclude that the observed relative stability of capital structure is an exception rather than the rule because firms actively re-balance capital structure. Further, the decompositional approach provides insights on whether or not the mixed results in the literature are largely due to the adoption of different measures of leverage.

This thesis uses five book-based measures of leverage in light of the considerable debate on the appropriate measure, and the observed compositional differences in corporate capital structure.[11] The five measures of leverage used for firm i in year t

[10] Fama and French (2002), Leary and Roberts (2005) and Rajan and Zingales (1995) use total debt, Byoun (2008), Flannery and Rangan (2006), and Shyam-Sunder and Myers (1999) use long-term debt, while Baum et al. (2013), Bevan and Danbolt (2002) and Flannery and Rangan (2006) use total liabilities as a measure of leverage. However, Rajan and Zingales (1995) highlight that including non-financial components (such trade credit, pension and employee liabilities) in the definition of leverage maybe misleading as it does not show if the firm is at risk of defaulting on its obligations.

[11] Rauh and Sufi (2010) highlight that the failure to recognise heterogeneity in corporate debt is one of the major limitations in the extant literature.

are constructed as follows:

$$TDA_{it} = \frac{Total\ Debt_{it}}{Total\ Assets_{it}} = \frac{Long\text{-}term\ debt_{it} + Short\text{-}term\ debt_{it}}{Total\ Assets_{it}}$$

$$NDA_{it} = \frac{Total\ Debt_{it} - Cash_{it}}{Total\ Assets_{it}}$$

$$LTDA_{it} = \frac{Long\text{-}term\ Debt_{it}}{Total\ Assets_{it}}$$

$$STDA_{it} = \frac{Short\text{-}term\ Debt_{it}}{Total\ Assets_{it}}$$

$$TLTA_{it} = \frac{Total\ Liabilities_{it}}{Total\ Assets_{it}}$$

Total debt

Total debt (TDA) is the main measure of leverage used in this thesis, and this is consistent with Fama and French (2002), Leary and Roberts (2005) and Rajan and Zingales (1995). Total debt includes long-term and short term debt divided by total assets. Rajan and Zingales (1995) highlight that when investigating agency problems associated with the use of debt, the most relevant measure is total debt. The main advantage of focusing on total debt is that it is not affected by non-financing components such as trade credit (which are used mainly for transactional purposes and cover temporary shortfalls in short-term financing) and employee and pension liabilities. These non-financing components are included in leverage, if leverage is measured based on total liabilities.[12] However, studies by Aktas et al. (2012), Demirguc-Kunt and Maksimovic (2001), Petersen and Rajan (1997) and Wu et al. (2012) report that trade credit is a major source of short-term financing, hence, its inclusion in the analyses of corporate financing decisions in this thesis.

Net-debt There is a debate on whether or not cash should be treated as negative debt, since it can be used to redeem outstanding debt. Acharya et al. (2007) report that the propensity to save out of cash flows increases with financial constraints and the need to hedge future financing gaps, which implies that firms hoard cash instead

[12]The role of trade credit in corporate financing decisions, and how it differs between innovative and non-innovative firms is examined in detail and separately in Chapter 6.

of reducing outstanding debt. This suggests that cash is negative debt for unconstrained firms or when the hedging motive is low, as these conditions present an opportunity to reduce outstanding debt using the excess cash. In order to examine the effects of cash on capital structure decisions, models that include net-debt (NDA) as a measure of leverage are estimated. This allows for comparisons to be drawn with studies on the US that report secular increases in cash holdings (e.g., Bates et al., 2009; Brown and Petersen, 2011; Faulkender, 2002; Faulkender and Wang, 2006; Ozkan and Ozkan, 2004; Seungjin and Jiaping, 2006). Also, the recent increases in cash holding in the US indicate that models of capital structure that exclude cash ignore important changes in financing policies.

Long-term debt

Long-term debt (LTDA) is consistently used as one of the most appropriate measure of leverage (see, Byoun, 2008; Flannery and Rangan, 2006; Shyam-Sunder and Myers, 1999). In a study that includes France, Germany and the UK over the period 1969-2000, Antoniou et al. (2006) highlight inconsistencies in a few prior studies that examine debt maturity structure. Long-term debt is included in models estimated in this thesis to investigate whether the type of investment undertaken by firms influences debt maturity decisions. Although theories of capital structure suggest that the nature of investments or corporate assets influence the debt-equity choice, there is limited empirical evidence of these linkages.[13] The major drawback of focusing only on long-term debt is that it ignores changes in short-term debt. Custódio et al. (2013) report a marked decrease in debt with maturity greater than three years of firms in the US. According to Custódio et al. (2013), the decrease in debt with maturity greater than three years from a peak of 53% in 1976 to 6% in 2008 is due to the increase in firms with information asymmetry problems. As these firms are mostly young, equity financing is most preferred, and if the firms use debt, they prefer debt with short maturity. Short-term debt presents opportunities to refinance at comparatively lower costs should the economic conditions or credit rating of the firm

[13]For the theoretical literature that examines the linkages between the nature of investments and capital structure see Diamond and He (2014), Myers (1977) and Stein (2003).

improve. Fama and French (2004) report similar changes as evidenced by a jump in new listings of firms that are young and financially weak in the US over the period 1980–2001.

Short-term debt

Abdulla et al. (2014a), Rashid and Caglayan (2012) and Titman and Wessels (1988) use short-term debt (STDA) as a proxy for leverage. Recently, Diamond and He (2014) present a model showing that the maturity risk arising from short-term debt has a stronger debt overhang effect on corporate investment than that from long-term debt. This model implies that firms with high information asymmetry (which increases with innovative investments) should use equity, and if they resort to using debt, it should be in the form of long-term debt as the debt overhang effects of short-term debt are much higher in the presence of information asymmetry. However, Custódio et al. (2013) highlight that it may be optimal for financially weak firms to finance using short-term debt as it presents opportunities to refinance at better credit terms in the future. Short-term debt is included in the analyses in this thesis as there are few studies on short-term debt, particularly in the UK, and on how it relates to different forms of corporate investments (R&D or capital expenditure).[14]

Total liabilities

Total liabilities (TLTA) is the broadest measure of leverage used in the analyses in this thesis. Baum et al. (2013), Bevan and Danbolt (2002) and Flannery and Rangan (2006) use a similar measure of leverage. The inclusion of trade credit in leverage allows for a broader view on how it relates to corporate investments. Further, several studies report that trade credit is a major source of short-term financing (e.g., Aktas et al., 2012; Demirguc-Kunt and Maksimovic, 2001; Petersen and Rajan, 1997; Wu et al., 2012). This implies that trade credit plays a more significant role in capital structure beyond the transactional role as reported by Rajan and Zingales (1995). Similarly, Biais and Gollier (1997) report that trade credit is important as it allevi-

[14] The only study on short-term debt in the UK by Rashid and Caglayan (2012) does not investigate the effects of R&D on short-term debt as it focuses risk.

ates information asymmetry in both the product (as customers can try the product before making a payment) and capital (suppliers have a comparative advantage in evaluating their customers and will lend more than banks) markets. Further, the focus on total liabilities as a measure of leverage allows for comparisons with prior studies and is a form of test for robustness.

Issues or repurchases of debt or equity

Issues or repurchases of equity or debt are defined as any net change in equity or debt that is in excess of 5%. This threshold is standard in the literature (e.g., Hovakimian et al., 2001; Hovakimian and Vulanovic, 2010; Leary and Roberts, 2005; Korajczyk and Levy, 2003). Results using alternative measures of debt and equity issuance are reported where available for robustness (Datastream account items WC04251 for issuance of equity and preference shares and WC04401 for issuance of debt are used). The analysis of issues or repurchases of debt or equity is largely confined to the US (see, Hovakimian et al., 2001; Hovakimian and Vulanovic, 2010; Leary and Roberts, 2005; Korajczyk and Levy, 2003). Extension of US studies to the UK offers an opportunity to draw fruitful comparisons on factors influencing decisions to access capital markets as Antoniou et al. (2008) and Oztekin and Flannery (2012) report that differences in the legal and institutional environments between two economies explain some of the observed variations in capital structure. Survey results by Beattie et al. (2006) also show that managers of firms in the UK prefer relatively lower levels of debt financing and use more short-term debt than their counterparts in the US.

Trade credit

Table 3.2 presents the account items from Datastream used in the construction of trade credit variables. The three book-based measures of trade credit used in Chapter 6 are constructed as follows:

$$AP_{it} = \frac{Trade\ Creditors_{it}}{Total\ Assets_{it}}$$

$$AR_{it} = \frac{Trade\ Debtors_{it}}{Total\ Assets_{it}}$$

$$NTC_{it} = \frac{Trade\ Debtors\ \text{-}\ Trade\ Creditors_{it}}{Total\ Assets_{it}}$$

Accounts payable to total assets (AP) and accounts receivable to total asset (AR) are the most commonly used measures of trade credit (e.g., Aktas et al., 2012; Uchida et al., 2013; Pindado and De La Torre, 2011). Aktas et al. (2012), Garcia-Appendini and Montoriol-Garriga (2013), Giannetti et al. (2011) and Love et al. (2007) use accounts payable to sales and accounts receivable to sales as measures of trade credit. Guariglia and Mateut (2006) highlight that scaling by total assets or sales does not materially change the results. The analyses in this thesis also use net trade credit as another measure of trade credit as it is more informative because it includes both accounts receivable and payable. Net credit is a more comprehensive measure of trade credit as most firms buy goods on credit while at the same time giving credit to their customers. According to Guariglia and Mateut (2006) using net trade credit allows for the study of the link between taking and giving trade credit, and how this relationship varies over time.

3.3.2 Independent variables

This section describes the construction of the variables proposed as the determinants of capital structure and trade credit. Recent reviews by Frank and Goyal (2009) and Oztekin (2015) highlight that there is considerable debate on the importance of the determinants of capital structure.[15]

Research and development

Research and development (R&D) is defined as the ratio of research and development expenditure to total assets. Other studies use the ratio of research and development expenditure to sales as a measure of R&D (e.g., Aghion et al., 2004; Begenau and Palazzo, 2015; Brown and Petersen, 2009; Hall, 2002; Hall and Lerner, 2010). However, the analyses in this thesis use research and development expenditure to total assets so as to address scaling effects that may arise if some variables used are scaled

[15] For earlier reviews on corporate capital structure, see Harris and Raviv (1991) and Titman and Wessels (1988).

by total sales. The analysis in this thesis is largely motivated by the limited studies on R&D and how it affects corporate decisions. Borisova and Brown (2013) report a fourfold increase in corporate spending on R&D to the extent of exceeding fixed capital expenditure (Capex) for most firms in the US over the period 1980-2008. Further, there are no comprehensive studies comparing how innovative and non-innovative firms differ with regards to corporate financing and trade credit decisions. Despite the increase in R&D, corporate debt levels, particularly in the UK, have remained largely persistent with an upward drift (Figure 3.1).

$$R\&D_{it} = \frac{Research\ \&\ Development\ Expenditure_{it}}{Total\ Assets_{it}}$$

Capex

Capex is defined as the ratio of capital expenditure to total assets. This measure is consistent with prior studies (e.g., Dang, 2011; Dudley, 2012; Morgado and Pindado, 2003). The relationship between investment and leverage is rather unclear as Aivazian et al. (2005), Dang (2011), DeAngelo and Masulis (1980) and Lang et al. (1996) report a negative relation, Lyandres and Zhdanov (2005) report a positive relation, and Mauer and Triantis (1994) report an insignificant relation. Further, the channels through which financing activities relate to investment decisions are the subject of considerable debate (Chava and Roberts, 2008; Stein, 2003), with Miller (1991) famously arguing that managers should not worry about "second order self-correcting activities" such as capital structure.

$$Capex_{it} = \frac{Capital\ Expenditure_{it}}{Total\ Assets_{it}}$$

Investment

Investment is defined as the ratio of capital expenditure plus research and development expenditure plus changes in working capital divided by total assets. Dudley (2012) uses a similar definition to study the effects of lumpy corporate investments on capital structure decisions. However, combining different forms of corporate investments tend to overlook heterogeneity and how this heterogeneity affects financing decisions. For example, R&D is mostly financed with equity as it is susceptible to high information asymmetry, asset substitution, longer investment horizons, and low pledgeable value issues (see, Borisova and Brown, 2013; Brown et al., 2012; Moshirian et al., 2013). The results from the analyses in this thesis presented below show that accounting for the differences in corporate investments is important to understand variations in capital structure.

$$Invest_{it} = \frac{Capital\ Expenditure_{it} + R\&D\ Expenditure_{it} + \Delta Working\ Capital_{it}}{Total\ Assets_{it}}$$

Other short-term liabilities

'Other short-term liabilities' is defined as the ratio of current liabilities less trade creditors divided by total assets. Guariglia and Mateut (2013) and Kling et al. (2014) report a positive effect of short-term debt on trade credit while Meltzer (1960) reports negative effect of short-term debt on trade credit. Mateut et al. (2006) and Yang (2011b) report that the relationship between short-term debt and trade credit changes with monetary policy, with the two being compliments under an expansionary regime and substitutes under a contractionary regime. This suggests that it is not clear whether the complementary or substitution effect of short-term debt on trade credit predominates.

$$Ostliab_{it} = \frac{Current\ Assets_{it} - TradeCreditors_{it}}{Total\ Assets_{it}}$$

Cash

Cash is defined as the ratio of cash and cash equivalent to total assets. Although there is a generally negative relationship between cash and leverage, Acharya et al. (2007) present a model showing that this relationship depends on the financial condition and hedging motives of firms. According to Acharya et al. (2007), financially constrained firms save cash without attempting to reduce outstanding debt and only reduce debt using excess cash if their hedging motive is low. Although the effect of cash on debt is largely negative, its effect on trade credit is a subject of debate. Petersen and Rajan (1997) report that cash has no significant effect on trade credit, while Bougheas et al. (2009), Dass et al. (2014) and Wu et al. (2012) report a significant negative effect. Lately, there has been a marked increase in cash holdings among firms in the US. Acharya et al. (2007), Acharya et al. (2012), Ang and Smedema (2011) and Bates et al. (2009) report secular increases in cash holdings in the US and attribute this to the growing need to increase corporate flexibility. In contrast to the results in the US, Figure 3.4e shows that cash holdings in the UK are relatively stable over time.

$$Cash_{it} = \frac{Cash\ and\ Cash\ Equivalent_{it}}{Total\ Assets_{it}}$$

Tangible assets

Tangible assets are defined as the ratio of property, plant and equipment to total assets. This is consistent with Byoun (2008), Faulkender et al. (2012) and Oztekin (2015). Tangible assets are used as a measure of collateral, which is expected to have a positive effect on debt financing. High collateral values, just like size, reduce information asymmetry problems (Holmstrom and Tirole, 1997; Leland and Pyle, 1977; Leland, 1998). However, the shrinking collateral values (tangible assets) in the US and UK (see, Figure 3.2c) have largely been overlooked in the literature, yet, it implies that there are changes in lending approaches as firms (with low collateral values) are able to access credit.[16] Similar decreases in tangible assets are also observable for UK firms in Figure 3.2c. Stroebel (2015) presents a model showing that integrated lenders with more information about collateral values are more willing to advance credit (to firms with specialised investments) at relatively lower interest rates than non-integrated lenders. This implies that firms may be able to access debt financing despite the significant decrease in tangible assets.

$$Tangible_{it} = \frac{Property\ Plant\ \&\ Equipment_{it}}{Total\ Assets_{it}}$$

Intangible assets

Intangible assets are defined the ratio of intangible non-current assets to total assets.

[16] Falato et al. (2013) report significant decreases in the US over the period 1996 - 2005, which implies that the debt capacity of firms has decreased over time as they have less pledgeable assets (collateral).

Although, intangible assets have been largely ignored in the literature, Figure 3.2d shows marked increases to levels similar to those of tangible assets. During the same period in which tangible assets decrease significantly, leverage remains persistent, with an upward drift. This trend is indicative of a positive relationship with debt financing.

$$Intangible_{it} = \frac{Intangible\ Assets_{it}}{Total\ Assets_{it}}$$

Growth

Growth (Tobin-q) is defined as the ratio of the market value of the firm to the book value of total assets (Byoun, 2008; Goyal et al., 2011; Graham and Leary, 2011; Liu, 2009). Although Alti (2003) and Erickson and Whited (2006, 2010, 2012) highlight the mis-measurement errors in the Tobin-q ratio, Adam and Goyal (2008) argue that this ratio has the highest information content about future investment opportunities compared to other proxies of growth opportunities (such as sales growth or analysts' forecasts).

$$Growth_{it} = \frac{Market\ Value\ of\ Equity_{it} + Total\ Assets_{it} - Book\ Value\ of\ Equity_{it}}{Total\ Assets_{it}}$$

Size

Size is defined as the natural logarithm of total assets, and this definition is consistent with Faulkender et al. (2012), Frank and Goyal (2009) and Graham et al. (2015). However, other studies use the natural logarithm of sales as a measure of firm size (e.g., Hovakimian and Vulanovic, 2010; Ozkan, 2001; Rajan and Zingales, 1995). Graham et al. (2015) highlight that there are no significant differences between using the natural logarithm of sales or total assets as a measure of firm size. Similarly, Titman and Wessels (1988) and Frank and Goyal (2009) report a high correlation between the two measures of firm size. Further, the high correlation between the logarithm of sales and total assets for firms used in this thesis suggests that using either the logarithm of size or sales lead to similar results.[17] Therefore, for the purposes of the

[17] The unreported correlation between the logarithm of sales and total assets for firms used in this thesis is 0.956.

analyses in this thesis, size is defined as the logarithm of total assets.

$$Size_{it} = \ln(Total\ Assets_{it})$$

Profit

Profit is defined as the ratio of earnings before interest and tax (EBIT) to total assets. Faulkender et al. (2012), Graham et al. (2015) and Oztekin (2015) use a similar measure of profitability. Profitability is widely used to test the predictions of the pecking order theory (e.g., Frank and Goyal, 2007b; Leary and Roberts, 2010; Vasiliou et al., 2009). A negative relation with leverage implies that a manager exhibits hierarchical preferences of financing sources as is consistent with the predictions of the pecking order theory. However, Jensen et al. (1992) report a positive relationship between profitability and leverage which is inconsistent with the predictions of the pecking order theory but consistent with the trade-off theory. The mixed results highlight that the effect of profitability on leverage is still not clear.

$$Profit_{it} = \frac{Earnings\ Before\ Interest\ \&\ Tax_{it}}{Total\ Assets_{it}}$$

Non-debt tax shield

Non-debt tax shield is the ratio of depreciation to total assets. Leary and Roberts (2005), de Miguel and Pindado (2001) and DeAngelo and Masulis (1980) use a similar measure, and report a negative relationship between non-debt tax shield and leverage. The negative relationship is consistent with the predictions of the model of DeAngelo and Masulis (1980) which posits that non-debt tax shield (such as depreciation, investment tax credit and net-loss carryforwards) are substitutes for the benefits arising from the interest deductibility of debt. However, Antoniou et al. (2008), Frank and Goyal (2009) and Titman and Wessels (1988) report a positive effect. Similarly, MacKie-Mason (1990) argues that the effect of the non-debt tax shield on leverage is likely to be insignificant as most of the shield elements are in the form of investment tax credit, which is only generated by a few highly profitable firms. Similarly, a review of the determinants of capital structure by Parsons and Titman

(2007) highlights the mixed results on the relationship between leverage and the non-debt tax shield. This suggests that there is still a debate on the exact effects of the non-debt tax shield on leverage.

$$NDTS_{it} = \frac{Depreciation_{it}}{Total\ Assets_{it}}$$

Asset turnover

In line with Serghiescu and Văidean (2014), asset turnover is defined as the ratio of sales to total assets. It is used to measure how efficiently firms manage their assets to generate revenue. Serghiescu and Văidean (2014) report a significant positive effect of asset turnover on leverage. However, Bastos and Pindado (2013) report that asset turnover has an insignificant effect on trade credit on a study of firms in Argentina, Brazil, and Turkey.

$$AssetTurn_{it} = \frac{Sales_{it}}{TotalAssets_{it}}$$

Volatility

Volatility is defined as the average 3-year rolling standard deviation of earnings. Earnings volatility is used to measure operating risk. This is in line with Krainer (2014) who shows that firms use capital structure to counteract changes in operating risk. Similarly, Dierker et al. (2013) report that firms adjust capital structure to manage risk. Antoniou et al. (2008) and Dang et al. (2012) highlight that firms with volatile earnings should use less debt as they may not be in a position to meet their debt obligations in bad macroeconomic environments (recessions). Further, Dang et al. (2012) report that volatile earnings tend to restrict access to capital markets.

$$Volatility_{it} = \frac{\sigma_{it} + \sigma_{it-1} + \sigma_{it-2}}{3}$$

where σ_{it} is the standard deviation of earnings for firm i at time t.

The following section presents descriptive statistics on all the variables used and discusses the emerging trends.

3.4 Descriptive Statistics

Table 3.3 presents descriptive statistics on the variables used. It reports firm-year observations (N), mean, standard deviation (Stdev), 25^{th} percentile, median, and 75^{th} percentile of leverage (total debt, TDA; net-debt, NDA; long-term debt, LTDA; short-term debt, STDA; and total liabilities, TLTA), trade credit (accounts payable, AP; accounts receivable, AR; and net trade credit, NTC), research and development dummy (*RDD*), research and development (R&D), capital expenditure (Capex), investment (Invest), other short-term liabilities (Ostliab), cash, tangible assets, intangible assets, growth, size, asset turnover (AssetTurn), non-debt tax shield (NDTS) and volatility.[18]

Across all firm-year observations, the mean (median) leverage ratio for total debt (TDA), net-debt (NDA), long-term debt (LTDA) and total liabilities (TLTA) is 20.6% (20.0%), 11.2% (12.9%), 12.7% (10.8%) and 55.3% (55.1%), respectively. The lower net-debt (NDA) relative to other leverage measures suggests that firms hold on average 9.4% of total assets in cash. About 61% of the firm-year observations (458 firms) have positive R&D, which suggests that a high proportion of firms in the UK are investing in R&D. The mean (median) R&D and capital expenditure for all firms in the sample are 1.60% (0%) and 5.70% (4.70%), respectively. The standard deviation of capital expenditure (10.9%) is relatively higher than that of R&D (4.3%) which is consistent with decreases in capital expenditure and increases in R&D. On average, capital expenditure is higher than R&D although it is decreasing over time. The low volatility of R&D is consistent with Borisova and Brown (2013) who report that during the recent global financial crisis, firms in the US continued to support investments in R&D by either selling-off assets or cutting back on capital expenditure. The mean (median) tangible assets and intangible assets is 33.2% (31.5%) and 9.20% (0.00%), respectively.

[18] The histograms in Appendix 3.B present the distribution of the variables used in the analyses. Appendix 3.B shows that these variables are not normally distributed. Further, considering some of the variables as endogenous requires the use of instrumental variables in estimation (discussed later in each of the empirical chapters). Appendix 3.D presents the time series averages of the variables used.

Table 3.3 Descriptive statistics

The table reports the number of observations (N), mean, median, standard deviation (Stdev), 25th and 75th percentiles for the variables used. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. Panel A presents the descriptive statistics for all firms. Panel B presents the differences between non-innovative and innovative firms in the mean of the variables used. Panel C presents estimates of the coefficients on the time trend from the regression of leverage or trade credit on a time trend. The sample consists of non-financial firms in the UK from the main official list of the London Stock Exchange over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Panel A

Variables	N	Mean	Stdev	25th	Median	75th
TDA	8396	0.206	0.120	0.118	0.200	0.279
NDA	8396	0.112	0.172	0.020	0.129	0.221
LTDA	8396	0.127	0.106	0.038	0.108	0.187
STDA	8396	0.093	0.132	0.023	0.058	0.118
TLTA	8396	0.553	0.158	0.453	0.551	0.654
AP	8396	0.134	0.090	0.069	0.121	0.181
AR	8396	0.228	0.118	0.145	0.225	0.300
NTC	8396	0.094	0.096	0.042	0.090	0.144
RDD	8396	0.496	0.500	0.000	0.000	1.000
R&D	8396	0.016	0.041	0.000	0.000	0.016
Capex	8396	0.057	0.048	0.026	0.047	0.074
Investment	8396	0.082	0.087	0.010	0.065	0.121
Ostliab	8396	0.293	0.126	0.211	0.275	0.355
Cash	8396	0.094	0.101	0.025	0.064	0.133
Tangible	8396	0.332	0.186	0.201	0.315	0.441
Intangible	8396	0.092	0.170	0.000	0.000	0.112
Growth	8396	1.544	1.014	1.030	1.312	1.748
Size	8396	12.104	2.134	10.564	11.699	13.503
Profit	8396	0.123	0.122	0.087	0.134	0.182
AssetTurn	8396	1.204	0.558	0.844	1.169	1.514
NDTS	8396	0.043	0.025	0.028	0.040	0.053
Volatility	8396	0.039	0.055	0.013	0.023	0.044

Panel B: Non-innovative and Innovative firms

	NIN			INN			Diff
Variables	N	Mean	Stdev	N	Mean	Stdev	(p-value)
TDA	3304	0.211	0.129	5092	0.203	0.114	(0.002)
NDA	3304	0.137	0.165	5092	0.095	0.175	(0.000)
LTDA	3304	0.130	0.116	5092	0.125	0.098	(0.020)
STDA	3304	0.101	0.152	5092	0.088	0.118	(0.000)
TLTA	3304	0.554	0.158	5092	0.552	0.158	(0.569)
AP	3304	0.147	0.107	5092	0.125	0.076	(0.000)
AR	3304	0.220	0.134	5092	0.233	0.107	(0.000)
NTC	3304	0.074	0.108	5092	0.108	0.085	(0.000)
RDD	3304	0.000	0.000	5092	0.818	0.386	(0.000)
R&D	3304	0.000	0.000	5092	0.260	0.050	(0.000)
Capex	3304	0.059	0.059	5092	0.570	0.039	(0.067)
Investment	3304	0.070	0.080	5092	0.090	0.090	(0.000)
Ostliab	3304	0.278	0.123	5092	0.303	0.127	(0.000)
Cash	3304	0.074	0.082	5092	0.107	0.109	(0.000)
Tangible	3304	0.342	0.219	5092	0.325	0.160	(0.000)
Intangible	3304	0.085	0.181	5092	0.097	0.162	(0.001)
Growth	3304	1.342	0.837	5092	1.676	1.093	(0.000)
Size	3304	11.586	1.752	5092	12.440	2.287	(0.000)
Profit	3304	0.112	0.116	5092	0.130	0.124	(0.000)
AssetTurn	3304	1.232	0.655	5092	1.186	0.484	(0.000)
NDTS	3304	0.040	0.028	5092	0.045	0.023	(0.000)
Volatility	3304	0.040	0.056	5092	0.038	0.054	(0.197)

Panel C: Trend*100

	TDA	NDA	LTDA	STDA	TLTA	AP	AR	NTC
ALL	0.114***	0.089***	0.280***	-0.120***	-0.110***	-0.180***	-0.400***	-0.220***
NIN	0.163***	0.120***	0.316***	-0.098**	0.027	-0.210***	-0.400***	-0.190***
INN	0.090***	0.099***	0.263***	-0.130***	-0.200***	-0.140***	-0.410***	-0.260***

Comparison of the differences between innovative firms and non-innovative firms in Panel B is based on non-parametric equality tests of the mean. Non-innovative firms use relatively higher leverage than innovative firms, with the differences in mean, being significant on total debt, net-debt and long-term debt. The relatively low leverage for innovative firms as implied by the non-parametric equality tests of the mean is consistent with prior studies. For example, Borisova and Brown (2013) and Brown and Petersen (2009) report that R&D subjects firms to binding credit constraints. The results in Panel B further show that innovative firms have relatively lower capital expenditure than non-innovative firms, although the differences are only marginally significant. Non-innovative firms have relatively higher tangible assets while innovative firms have higher intangible assets. This is generally expected as innovative firms invest more in intangible assets while non-innovative firms concentrate on tangible assets. The differences in the mean of the control variables between innovative and non-innovative firms are largely significant, except for volatility.[19] In general, innovative firms have relatively higher growth, size, profit and non-debt tax shield, whereas non-innovative firms have higher earnings volatility.

The results in Panel C provide prima facie evidence on the trend of leverage and trade credit over time. The coefficients on the time trend are highly significant, except for total liabilities of non-innovative firms. Panel C shows a statistically significant upward trend on total debt and net-debt, and a downward trend on short-term debt, total liabilities and accounts payable. The trends are indicative of a significant shift towards debt with longer maturity. Further, there are marked differences between innovative and non-innovative firms in the trend coefficient of leverage and trade credit but not for accounts receivable. This preliminary result is consistent with Panel B and indicates that there are differences in trends of debt and trade credit between innovative and non-innovative firms.

The trends in leverage and trade credit over time, and how leverage and trade credit

[19] Growth, size, profit, asset turnover, non-debt tax shield and volatility are used as control variables in the analysis in this thesis.

relate to changes in firm characteristics, is examined further in the following subsections.

3.4.1 Evolution of corporate leverage and collateral

Figure 3.1 shows time-series plots of mean leverage ratios (total debt, net-debt, long-term debt, short-term debt and total liabilities) and debt-to-collateral ratios (total-debt-to-collateral, net-debt-to-collateral, long-term debt-to-collateral, short-term-debt-to-collateral and total-liabilities-to-collateral). ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. Appendix 3.D presents the time series averages used to construct Figure 3.1.

Figure 3.1 indicates that the financing structure of firms varies significantly over time. There are three observable peaks (1991, 2003, and 2008) in leverage ratios. From 1987 to 1991 there is an increase in debt, followed by a decrease to 1997. Total debt initially increases from 1987 to 1991, falls temporarily between 1992 and 1994, and rises to 2003. Although total debt fluctuates over time, it exhibits an upward drift throughout the period 1987-2013. Also observable are trends of increasing reliance on long-term debt and marked decreases in short-term debt from 1990 to 2013. Prior to 1990, most corporate debt in the UK is predominantly short-term (on average 80%), with long-term and short-term debt converging from 1990 to 1993. Thereafter, there is a marked reversal in financing trends as the proportion of long-term debt increases progressively, reaching a peak of 71% (on average 63%) of total corporate debt in 2012. The decrease in short-term debt is more pronounced for innovative firms, which would be consistent with the existence of binding financial constraints and the need to avoid roll-over risk. Similarly, Kahl et al. (2015) report that firms with a high roll-over risk are more likely to use more long-term debt and less short-term debt. A large proportion of the decrease in total liabilities from 1990 onwards, is attributable to the decrease in short-term debt (Figure 3.1i) and other short-term liabilities (Figure 3.4e). This shows less reliance on short-term financing sources,

Figure 3.1 **The evolution of leverage and collateral**

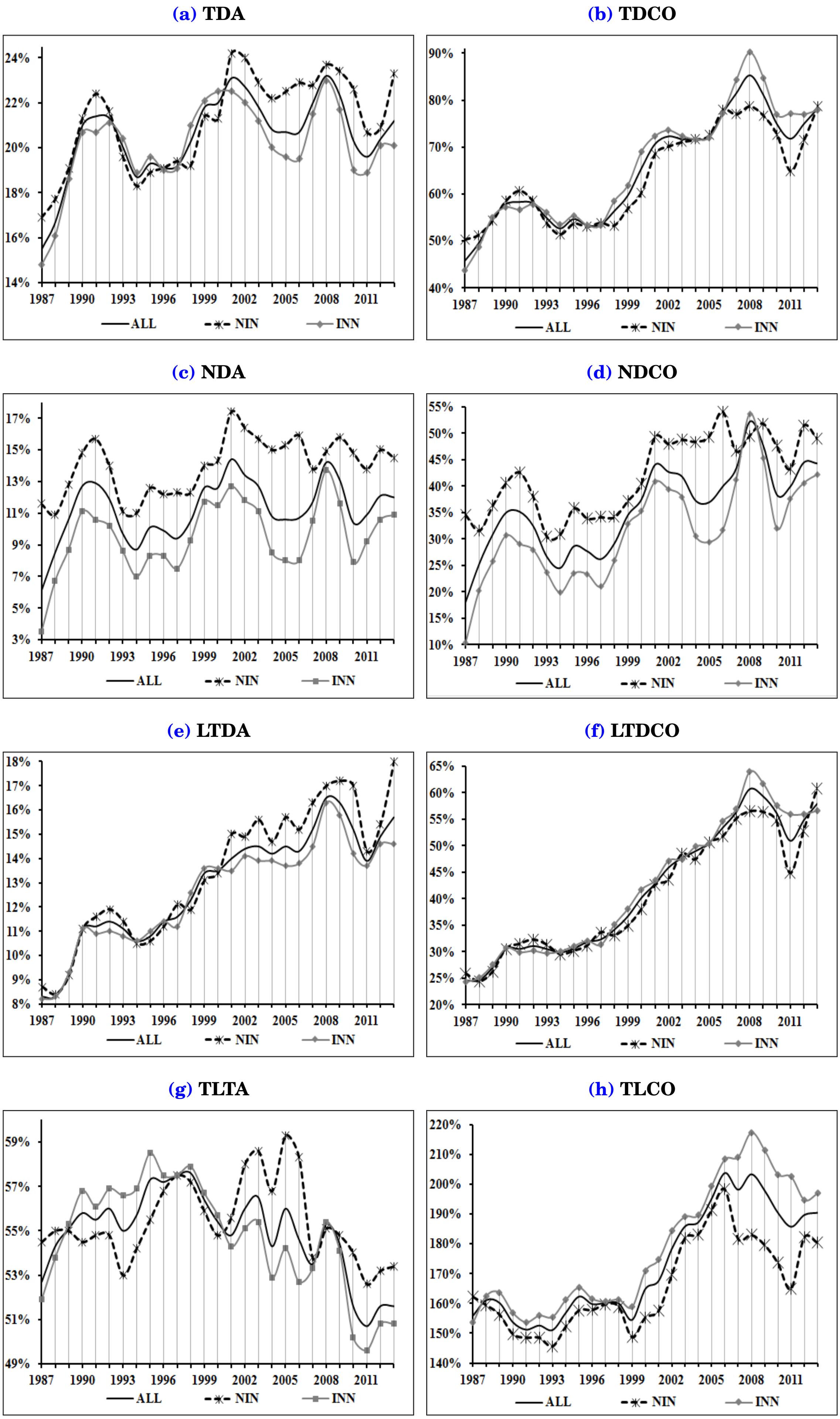
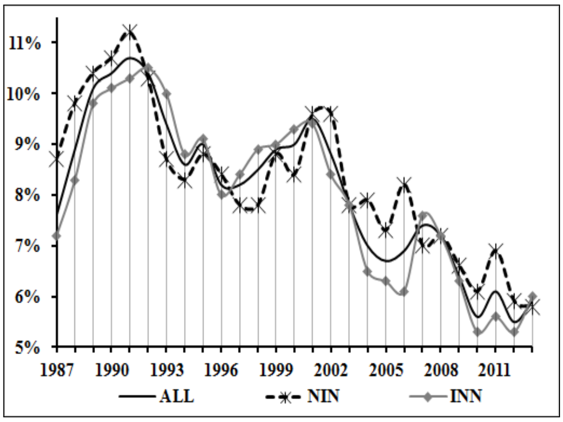
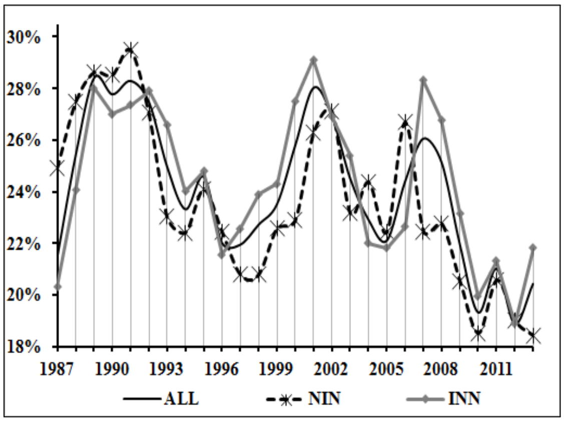


Figure 3.1 The evolution of leverage and collateral (continued)

(i) STDA



(j) STDCO



which is in contrast to Custódio et al. (2013) who report an increase in short-term debt among firms in the US (they attribute the decrease in long-term debt between 1976 to 2008 to de-leveraging activities of small firms).

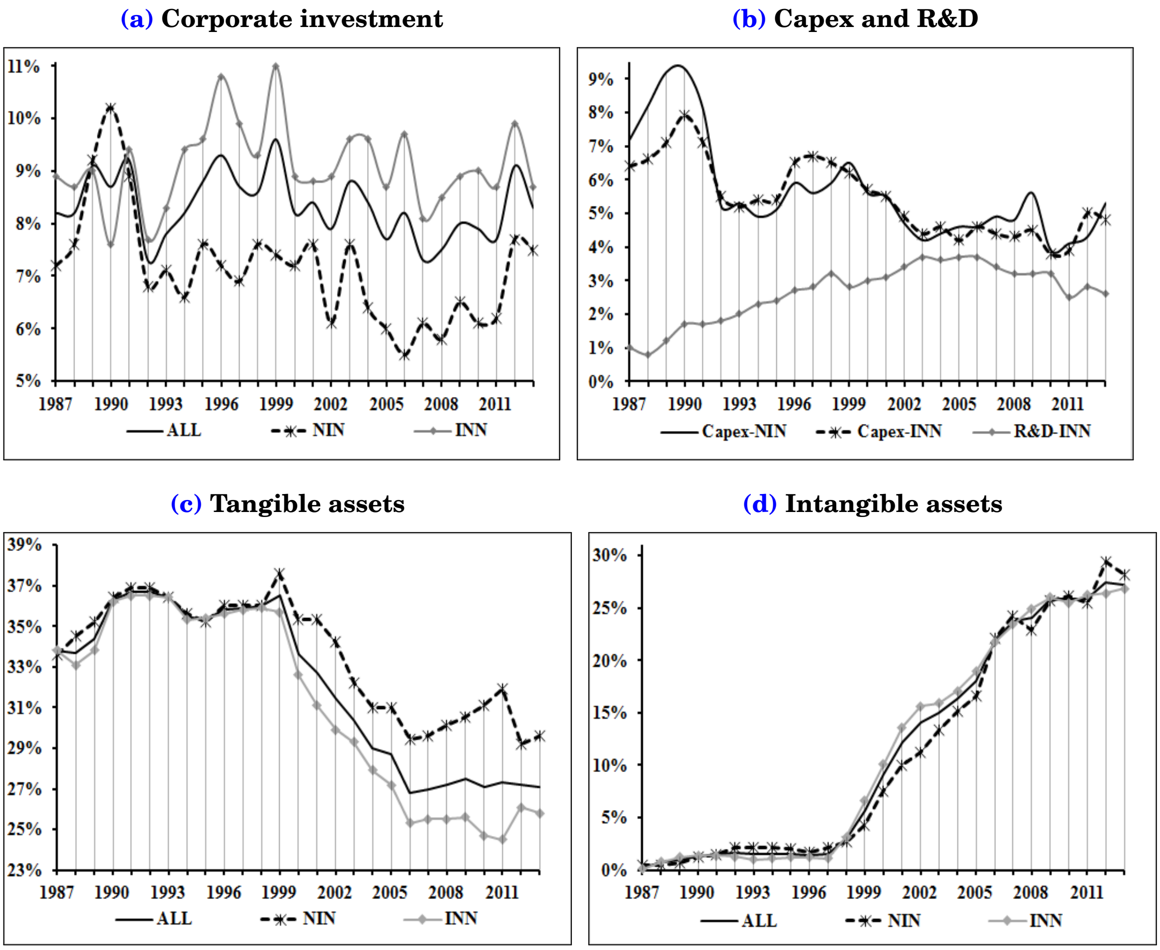
Comparisons of trends on leverage between non-innovative and innovative firms show they use similar proportions of debt financing, except that the former use relatively more total debt than the latter during the period from 2000 to 2013. The relatively similar levels of total debt from 1987 to 1999 is inconsistent with existing empirical evidence in the US that R&D should be financed mostly with equity (e.g., Borisova and Brown, 2013; Brown et al., 2009; Hall, 2002, 2009). However, Chava et al. (2013) report that banks that have experience in lending to innovative firms (specialised lenders) recognise the value of innovation (intangible investments) and provide credit at comparatively lower rates than non-specialised lenders. Further, the net-debt of innovative firms as shown in Figure 3.1c has a comparatively higher standard deviation of 17.5% relative to the 16.5% for non-innovative firms (see, Table 3.3). This is opposite to the results of the volatility of total debt, as non-innovative firms (12.9%) have higher volatility than innovative firms (11.4%) in Figure 3.1a. The relatively high standard deviation of net-debt (Table 3.3) is due to the high variability in cash, with innovative firms holding comparatively more cash than non-innovative firms. The total debt and long-term debt of non-innovative firms are more volatile than those of innovative firms, while there are no significant differences in the volatility of total liabilities. This is inconsistent with Brown et al. (2009) who report lower leverage levels for firms with R&D in the US over the period 1990-2004.

Similar differences as those on total debt (Figures 3.1a and 3.1b) between innovative and non-innovative firms are observable on trends in long-term debt and total liabilities. However, the result on net-debt is the opposite of that on other measures of leverage, as non-innovative firms have relatively higher levels of net-debt than innovative firms. Consistent with the this result, Figure 3.4f shows that innovative firms hold relatively more cash holdings than non-innovative firms, which result in low net-debt. The comparatively high cash holdings of innovative firms as shown in Figure 3.4f is consistent with the proposition that these firms hoard cash to smoothen the funding for R&D (e.g., Brown et al., 2009; Brown and Petersen, 2011; Buera and Kaboski, 2012). However, in contrast to results in the US, a study of a sample of Taiwanese firms by Sheu and Lee (2012) reports that excess cash is significantly correlated with capital expenditure, while it is insensitive to R&D for financially constrained firms (with severe managerial entrenchment). The recent literature on investment-cash-flow sensitivity (ICFs) reports similar contradictory results on the linkages between cash and R&D. [20] This leaves the question of how the relationship between investment and financing activities has changed over time largely unanswered. The analysis in this thesis investigates the changes in this relationship in the UK by drawing comparisons between innovative and non-innovative firms.

Overall, the persistence in leverage and the increasing collateral-to-debt ratios (Figures 3.1b, 3.1d, 3.1f and 3.1h) is inconsistent with collateral based lending. This implies that an increasing proportion of intangible assets are financed using debt. The following subsection presents a discussion of the time variations in corporate investments and corporate assets.

[20] For example, in a study of 45 countries Moshirian et al. (2013) attribute the decrease in investment-cash flow sensitivity to the increase in R&D. This decrease in investment-cash flow sensitivity is inconsistent with what is expected, as the increase in R&D and the decrease in fixed capital expenditure should result in marked increases in investment-cash-flow sensitivity. Brown et al. (2009) report that R&D subject firms to binding financial constraints. If investment-cash-flow sensitivity are a good measure of financial constraints, then the R&D-cash-flow sensitivity should be relatively higher than that of fixed capital expenditure. Chen and Chen (2012) report similar decreases in investment-cash flow sensitivity in the US.

Figure 3.2 The evolution of corporate investments and assets



3.4.2 Evolution of corporate investments and corporate assets

Figure 3.2 plots annual averages of total investments (includes capital expenditure, R&D and changes in working capital), capital expenditure (Capex), and research and development (R&D) over time. The figure also shows the time series evolution of corporate assets (tangible assets and intangible assets). ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. Appendix 3.D presents the time series averages used to construct Figure 3.2.

Figure 3.2 shows that capital expenditure (Capex) is generally decreasing over the sample period, with temporary increases during the periods 1987-1990, 1994-1998, 2005-2007, 2008-2009, and 2010-2013. There are marked increases in R&D during the periods 1989-1998 and 2000-2003, and a decrease from 2006 to 2011. The marked changes in corporate investments has implications for corporate financing policies as intangible investments (R&D), which are characterised by high specificity, asset substitution, and low collateral value (see, Buera and Kaboski, 2012), are likely to increase susceptibility to financial constraints (see, Brown et al., 2012). However, the increase in R&D and the decrease in tangible assets shown in Figure 3.2 has not been matched by a corresponding decrease in debt financing, which has remained largely persistent with an irregular sinusoidal wave that has a slight upward drift as shown in Figures 3.1a, 3.1c and 3.1e.[21] This preliminary result indicates that firms are still able to access debt financing despite significant changes over time in corporate investments and corporate assets.

Tangible assets are relatively stable from 1987 to 2000, then they decrease rapidly from 2001 to 2013, except for a temporary recovery by non-innovative firms between 2006 and 2011. The decrease in tangible assets from 2001 to 2013 is consistent with Figures 3.1b, 3.1d, 3.1f and 3.1h, which show a large increase in debt-to-collateral ratio. This suggests a marked decrease in corporate debt capacity (assuming collateral based lending). Figure 3.2d shows an opposite trend, with intangible assets remaining relatively low from 1987 to 1998, and increasing rapidly thereafter. The increase in intangible assets after 1998 suggests that firms should increase equity and decrease debt, as intangible assets are a poor form of collateral. According to Brown et al. (2012), innovative investments are prone to information asymmetry, asset substitution and high specificity issues. The decrease in collateral values is difficult to reconcile with the persistent and upward drift in corporate debt levels, and the proposition that a fall in tangible assets should result in de-leveraging (e.g., Campello and Giambona, 2013; Goyal et al., 2011; Oztekin, 2015). The persistent leverage suggests that an increasing proportion of debt is supported by intangible assets which are traditionally considered to be poor a form of collateral.[22]

[21] Lemmon et al. (2008), Hanousek and Shamshur (2011) and Xu and Baranchuk (2008) report that leverage is highly persistent. However, DeAngelo and Roll (2015) report that the stability of leverage is only a temporary phenomenon, with greater variations occurring in the long-run.

[22] Arrow (1962) and Nelson (1959) present models which show that intangible assets are a poor form of collateral. Despite this theoretical predictions, there are no empirical studies investigating how changes in corporate assets affects corporate debt financing.

The next sub-section presents a discussion of the other firm characteristics (used as control variables in the analyses in this thesis) usually associated with corporate debt and trade credit.

3.4.3 Evolution of other firm characteristics

Figure 3.3 presents time series plots of the annual cross-sectional mean of size, growth, profit, non-debt tax shield, volatility and asset turnover from 1987 to 2013. As before, ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. Appendix 3.D presents the time series averages used to construct Figure 3.3.

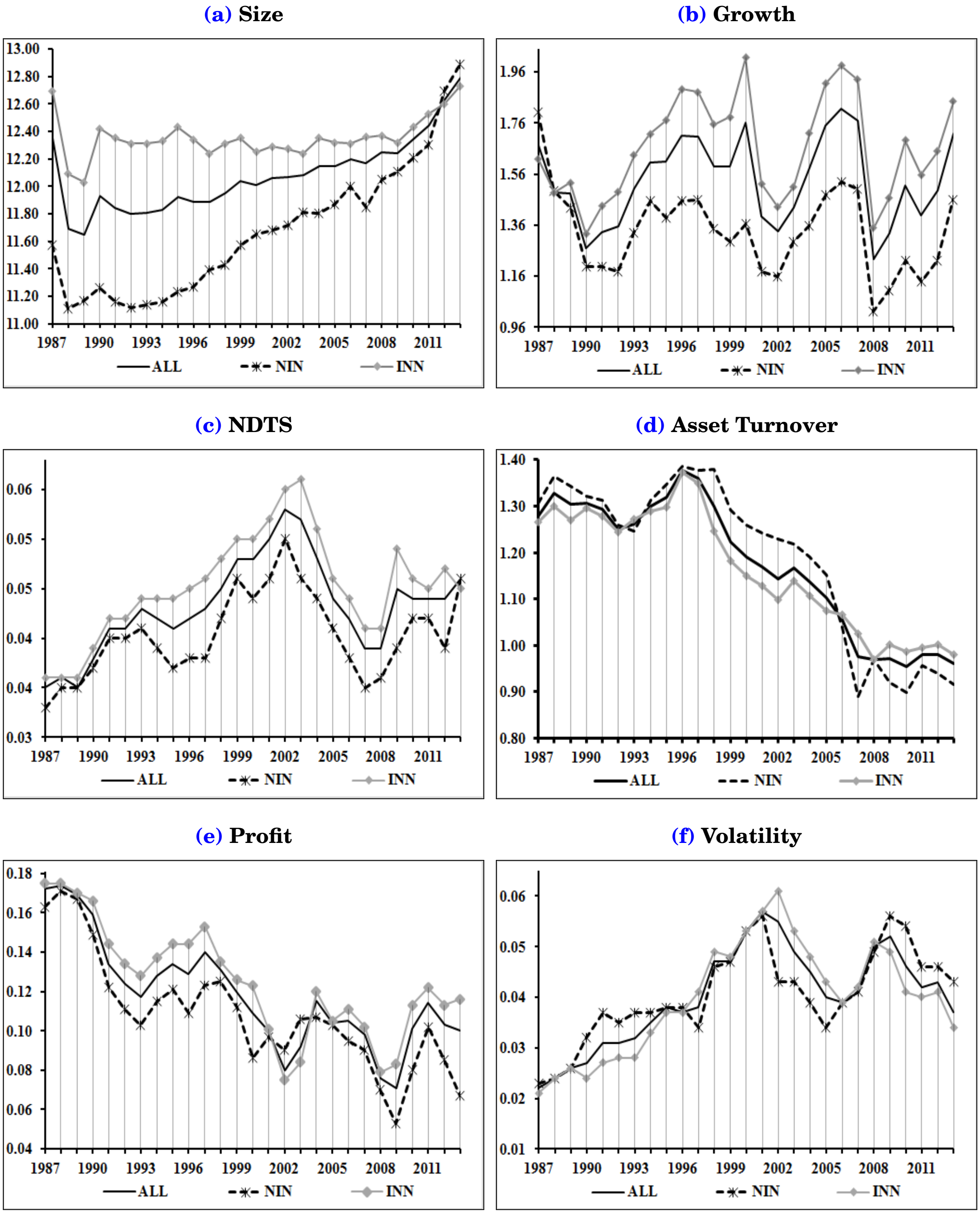
Figure 3.3a indicates that size exhibits an increasing trend from 1988 onwards. The increase from 2009 is rapid and is largely driven by the exit from the database of firms that faced financial distress during the recent financial crisis (mostly small firms). The recent global financial crisis is marked by an increase in the number of firms that went into receivership and liquidation. According to Ivashina and Scharfstein (2010), corporate bankruptcy in the US peaked in 2008 and 2009. Similarly, Appendix 3.A shows that the proportion of firms in the sample decreased progressively from 2000 to 2013.[23] The increase in size (Figure 3.3a) is driven by the growth in intangible assets (as shown in Figure 3.2c and 3.2d), which should usually be financed with equity. Yet, leverage exhibits persistence with a general upward drift.[24]

Figure 3.3b shows large fluctuations in firm growth, but the general trend is relatively flat. Comparisons of growth rates between innovative and non-innovative firms suggests that they experience similar growth patterns, although innovative

[23]This shows that the majority of the observations in the sample are concentrated over the period 1987-2000. This period reflects an influx of small innovative and high growth firms prior to the tech-bubble. Fama and French (2004) report similar trends in new listings in the US, with these listings being conducted mostly by young and high growth firms with weak balance sheets. They attribute this influx of new listings by financially weaker firms (which would not ordinarily access public markets) to a decline in the cost of equity.

[24]Graham et al. (2015) highlight that examining the relationship between the trend in firm size and corporate debt financing in the US is problematic as firm size increases progressively with economic growth.

Figure 3.3 **Changes in firm characteristics**



firms consistently have higher growth rates, with a marked divergence between the two type of firms from 1990 to 1996. There is considerable debate on how growth affects leverage, with some studies (e.g., Antoniou et al., 2008; de Jong et al., 2008; Frank and Goyal, 2009; Oztekin, 2015) reporting a negative effect while others (e.g., Dang et al., 2012; Dang, 2013a; Dang et al., 2014a; de Jong et al., 2008; Drobetz and Wanzenried, 2006; Oztekin and Flannery, 2012) reporting a positive effect. Trends of growth in Figure 3.3b do not allow for conclusive visual interpretations of how the variables relate to the largely persistent and rising debt levels shown in Figure 3.1.

Non-debt tax shield is negatively related to leverage, which is a substitute for tax shield (Goyal et al., 2011; Oztekin, 2015). Figure 3.3c shows that non-debt tax shield increases from 1987-2003, and decreases from 2004 to 2007, before increasing again. The general decrease in non-debt tax shield from 2004 to 2007 is consistent with trends in tangible assets (Figure 3.2c) which show marked changes in corporate assets. However, the trend in non-debt tax shield is difficult to relate to changes in leverage as there appear to be a weak positive relationship, which is inconsistent with the literature (e.g., de Miguel and Pindado, 2001; Leary and Roberts, 2005; Goyal et al., 2011; Oztekin, 2015). Figure 3.3d shows that asset turnover decreased rapidly from 1998 to 2008 and stabilised thereafter. The decrease in asset turnover is rather difficult to reconcile with macroeconomic conditions in the UK, as the economy did not experience a recession from the late 1990s up to the recent global financial crisis. The decrease in asset turnover also occurs concurrently with a marked change in corporate assets. Given that asset turnover is positively related to leverage (Serghiescu and Văidean, 2014), the decrease in asset turnover (Figure 3.3c) should lead to a decrease in leverage. However, Figure 3.1 shows that leverage is persistent and suggests that asset turnover is negatively related to corporate debt.

Figure 3.3e shows that on average, firms in the UK have become less profitable over time. However, contrary to prior literature in the US, innovative firms are relatively more profitable than non-innovative firms, except from 2001 to 2004.[25] The relatively low profitability of innovative firms during the period 2001-2004 coincides with the tech-bubble during which several technologically oriented firms were liquidated. Consistent with the pecking order theory, Goyal et al. (2011), Liu (2009) and Warr et al. (2012) report a negative relationship between leverage and profitability. Antoniou et al. (2008) and Oztekin and Flannery (2012) report similar results for

[25] Fama and French (2004) report that on average, high growth firms in the US are financially weak and less profitable.

firms in the UK and around the world, respectively. Thus, the general decrease in profitability shown in Figure 3.3e should result in an increase in corporate debt, if an inverse relationship exists between these two variables. However, the decrease in profitability also implies that firms'ability to meet debt obligations has decreased and, hence, the need to reduce debt financing.

Figure 3.3f shows that earnings volatility has increased, on average, peaking around 2001, decreasing temporary until 2005, increasing from 2006 to 2009, and falling thereafter. Trends in earnings volatility mirror general economic conditions as they peak around 2000 and trough around 2009 coinciding with the tech-bubble and the global financial crisis, respectively. This is consistent with Brandt et al. (2010), Campbell et al. (2001) and Kang et al. (2011) who report a similar increase in idiosyncratic risk in the US. In contrast to Brandt et al. (2010) who report a partial reversal in idiosyncratic risk by 2003 in the US, Figure 3.3f shows that the reversal is temporary in the UK, as earnings volatility increase again from 2005 to 2009. The concurrence of the persistence in leverage and the general upward trend in earnings volatility is rather contradictory to the theory and existing empirical evidence. Theory predicts that in the presence of increasing operating risk, firms respond by adopting conservative financing structures (Krainer, 2014). Consistent with the deleveraging hypothesis, Dang (2011) reports a negative relation between leverage and earnings volatility in the UK for the period 1996-2003. However, interpreting the visual trends in earnings volatility (Figure 3.3f) and leverage (Figure 3.1) suggests a positive relation, which is rather surprising.

Overall, the change in other firm characteristics is difficult to reconcile with the largely persistent and increasing trends in leverage, while the trends in leverage determinants suggest that it should decrease over time. This raises new questions on how, and in what way, have the relationships between capital structure and its determinants changed over the past decades.[26] Chapter 4, 5 and 6 investigate changes

[26]Survey evidence from Chief Finance Officers (CFOs) in the US by Graham and Harvey (2001) show large differences between theory and practice. Similarly, Graham et al. (2015) report that the factors commonly associated with capital structure (size, profit, tangible assets and market-to-book

in the relationship between leverage (including trade credit) and firm characteristics using sub-period analyses and rolling regressions over the sample period.

3.4.4 Evolution of trade credit, short-term debt and cash

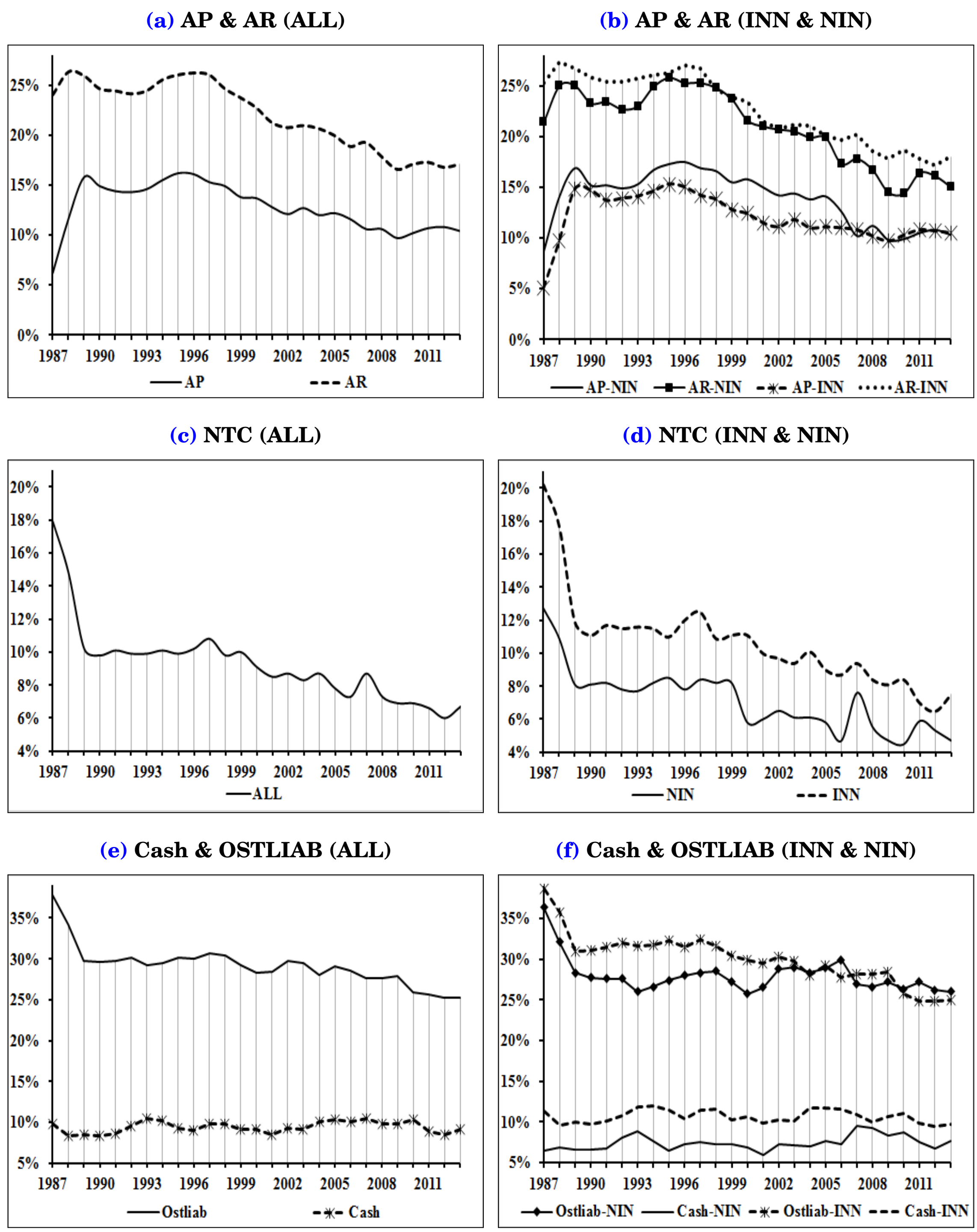
Figure 3.4 presents time plots of the average trade credit, short-term liabilities and cash holdings over the sample period. Trade credit is defined as either accounts payable (AP) or accounts receivable (AR). Net trade credit (NTC) is the difference between accounts receivable and accounts payable. Appendix 3.D presents the time series averages used to construct Figure 3.4.

Figure 3.4a shows a gradually decreasing trend in trade credit from 1989 to 2013, accounts payable decreased from a peak of 25% in 1988 to below 15% in 2013. A similar downward trend is also observable in accounts receivable. Figure 3.4c shows that net trade credit also decreased over time. This decrease is rather inconsistent with the changes in firm characteristics (size, growth, cash and other short-term debt) discussed above, except for the decrease in profitability and asset turnover. Trade credit should increase with growth, as firms have to offer more goods on credit to increase sales, and should decrease with cash, as firms have to increase cash sales to increase liquidity. Similarly, trade credit should increase with decreases in short-term debt if short-term debt and trade credit are substitutes (Dass et al., 2014). The decrease in profitability and asset turnover (Figure 3.3) suggests that firms have less ability to give credit and are, on average, selling less (as also shown by the decrease in asset turnover).

Figure 3.4b shows that in general innovative firms use less and give more trade credit than non-innovative firms. The differences are more pronounced in net trade credit (Figure 3.4d) and provide prima facie evidence that trade credit policies differ across these two types of firm. This finding is in contrast to the proposition that firms with innovative investments are subject to binding financial constraints, which would result in an increasing reliance on trade credit and less credit extended to customers.

value) are progressively explain less of the observed variations in financing structures.

Figure 3.4 Trade credit, cash and other short-term liabilities



However, the informational advantages and control over the buyer hypothesis posits that firms with unique products may be more willing to give credit to their customers (Biais and Gollier, 1997; Brennan et al., 1988; Smith, 1987). Consistent with this hypothesis, Stroebel (2015) presents a model showing that non-integrated lenders charge comparatively higher interest rates than integrated lenders to compensate for the high information asymmetry in collateral values. The comparative advantages of suppliers in collecting information on the credit worthiness of customers (with this advantage increasing with product uniqueness) as Cuñat (2007) and Petersen and Rajan (1997) highlight, may explain the relatively high trade credit being provided by innovative firms (these are mostly the suppliers of unique or specialised products). This prediction is tested in Chapter 6 by drawing comparisons of the determinants of trade credit between innovative and non-innovative firms.

Important variations in trade credit also emerge during the recent global financial crisis. The variability of accounts payable suggests that non-innovative firms use more trade credit than innovative firms except for the early 1990s and late 2000s. Figure 3.4b shows that innovative firms give more trade credit (accounts receivable) than non-innovative firms. The difference in accounts receivable between these two types of firms is higher during the early 1990s and late 2000s. These two periods coincide with major recessions in the UK. This suggests that innovative firms are more willing to support their customers during crisis periods by offering goods on credit. Further, the dynamics of accounts receivable suggests that there are time varying differences on trade credit policies between non-innovative firms and innovative firms.

Figure 3.4e shows that other short-term liabilities are decreasing while cash is relatively stable over time. The general decrease in other short-term liabilities that occurs at the same time as the decrease in trade credit indicates the existence of a positive visual association (complimentary relationship). However, results in the literature on how trade credit relates to short-term debt are rather mixed. One strand suggests that they are substitutes (e.g., Dass et al., 2014; Meltzer, 1960) while the other (e.g., Cuñat, 2007; Garcia-Appendini and Montoriol-Garriga, 2013; Love et al., 2007; Wu et al., 2012) suggests that they are compliments. Similarly, Meltzer (1960) and Yang (2011b) report that the relationship between trade credit and bank credit varies over time with changes in monetary policy. The stability of cash in UK firms over time shows no clear relationship with trade credit. Innovative firms consistently have more cash and other short-term liabilities than non-innovative firms. This comparatively high cash-holding suggests that flexibility is more important for innovative firms than non-innovative firms. This is consistent with O'Brien (2003) who report that maintaining flexibility is critical for survival in highly competitive innovative product markets. However, the relatively high other short-term liabilities of innovative firms is inconsistent with the need to maintain flexibility by reducing short-term debt and the need to match the maturity of assets to financing sources (Diamond, 1991; Hart and Moore, 1994). Trends in other short-term liabilities, cash and trade credit do not provide a clear visual relationship. Overall, the decrease in trade credit is rather difficult to reconcile with changes in firm characteristics. This warrants further analysis in Chapter 6 which investigates the changes in trade credit and the determinants of trade credit.

3.4.5 Correlations

Table 3.4 presents the correlations between the variables used. As expected, the leverage variables (total debt, net-debt, long-term debt, total liabilities) are positively correlated with each other, except for short-term debt which is negatively correlated with long-term debt. The negative correlation between these latter two variables suggests that long-term and short-term debt are substitutes. Trade credit (accounts payable) is negatively correlated with all leverage variables (except for total liabilities) as is consistent with the proposition that trade credit is a substitute to other financing sources (Dass et al., 2014; Meltzer, 1960). Similarly, accounts receivable is negatively correlated with total debt, net-debt and long-term debt, while it is positively correlated with short-term debt, total liabilities and accounts payable. The positive correlation is prima facie evidence that firms in the UK use financing from short-term debt, total liabilities and accounts payable to increase the credit they give to their customers.

Table 3.4 shows that leverage is negatively correlated with R&D, growth, profit and earnings volatility, and positively correlated with size, capital expenditure, tangible and intangible assets. The correlations are mostly of the signs expected, and consistent with the literature, except for intangible assets. The positive correlation between

Table 3.4 Correlations

The table presents correlations between the variables used. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Variables	1	2	3	4	5	6	7	8	9	10	11
1.TDA	1										
2.NDA	0.821***	1									
3.LTDA	0.765***	0.605***	1								
4.STDA	0.251***	0.228***	−0.077***	1							
5.TLTA	0.558***	0.483***	0.395***	0.142***	1						
6.AP	−0.193***	−0.064***	−0.267***	−0.028***	0.374***	1					
7.AR	−0.168***	−0.055***	−0.297***	0.045***	0.302***	0.605***	1				
8.NTC	−0.026**	−0.008	−0.115***	0.082***	0.022**	−0.193***	0.665***	1			
9.*RDD*	−0.019*	−0.120***	0.017	−0.072***	−0.025**	−0.145***	−0.033***	0.096***	1		
10.R&D	−0.127***	−0.262***	−0.090***	−0.054***	−0.106***	−0.065***	0.020*	0.085***	0.388***	1	
11.Capex	0.023**	0.045***	0.040***	0.016	−0.066***	−0.091***	−0.076***	−0.008	−0.032***	−0.023**	1
12.Investment	−0.102***	−0.204***	0.011	−0.091***	−0.145***	−0.076***	−0.013	0.055***	0.145***	0.319***	0.300***
13.Ostliab	0.198***	0.145***	−0.153***	0.265***	0.668***	−0.017	0.198***	0.260***	0.060***	−0.009	−0.051***
14.Cash	−0.214***	−0.733***	−0.124***	−0.092***	−0.161***	−0.121***	−0.107***	−0.018	0.183***	0.298***	−0.048***
15.Growth	−0.093***	−0.225***	−0.049***	−0.047***	−0.016	−0.083***	0.026**	0.110***	0.173***	0.328***	0.074***
16.Tangible	0.110***	0.193***	0.144***	0.004	−0.137***	−0.214***	−0.261***	−0.120***	−0.037***	−0.140***	0.521***
17.Intangible	0.171***	0.175***	0.276***	−0.048***	0.008	−0.266***	−0.271***	−0.084***	0.078***	0.042***	−0.250***
18.Size	0.215***	0.134***	0.361***	−0.104***	0.141***	−0.328***	−0.413***	−0.201***	0.232***	−0.057***	0.000
19.Profit	−0.111***	−0.052***	−0.025**	−0.078***	−0.067***	−0.084***	0.033***	0.119***	0.039***	−0.160***	0.165***
20.AssetTurn	−0.216***	−0.069***	−0.318***	0.002	0.303***	0.678***	0.651***	0.166***	−0.094***	−0.049***	−0.023**
21.NDTS	0.010	0.020*	0.014	0.009	0.007	−0.044***	0.019*	0.065***	0.114***	0.187***	0.370***
22.Volatility	0.028***	−0.045***	−0.043***	0.068***	0.037***	0.029***	0.024**	0.003	0.005	0.175***	0.029***

Variables	12	13	14	15	16	17	18	19	20	21	22
12.Investment	1										
13.Ostliab	−0.136***	1									
14.Cash	0.228***	−0.011	1								
15.Growth	0.219***	0.084***	0.273***	1							
16.Tangible	0.054***	−0.141***	−0.200***	−0.11 ***	1						
17.Intangible	−0.116***	−0.032***	−0.097***	0.05***	−0.391***	1					
18.Size	−0.042***	0.104***	0.026**	0.018*	0.125***	0.173***	1				
19.Profit	0.156***	−0.009	−0.044***	0.116***	0.130***	−0.113***	0.182***	1			
20.AssetTurn	−0.028***	0.167***	−0.139***	−0.03 ***	−0.156***	−0.315***	−0.327***	0.115***	1		
21.NDTS	0.165***	0.035***	−0.022**	0.087***	0.344***	−0.029***	−0.127***	0.007	0.087***	1	
22.Volatility	0.051***	0.067***	0.111***	0.062***	−0.061***	0.053***	−0.200***	−0.479***	−0.011	0.220***	1

leverage variables and intangible assets is rather inconsistent with the proposition that intangible assets should be financed with equity.[27,28] It is reassuring to note that all other independent variables are not highly correlated with leverage variables, except for net-debt and cash which are by definition closely related.[29]

As expected, accounts payable is highly correlated with accounts receivable which suggests that firms that give more trade credit in turn also buy goods on credit. Both trade credit variables are negatively correlated with total debt, net-debt, other short-term debt, cash, the presence of research and development, tangible assets, intangible assets and size. Asset turnover, profit and earnings volatility are positively correlated with accounts payable, while profit is negatively correlated with accounts payable. This suggests that profitable firms provide more trade credit to their customers as is consistent with studies in the US (e.g., Giannetti et al., 2011), the UK (e.g., Kling et al., 2014) and China (e.g., Guariglia and Mateut, 2013; Wu et al., 2012). All the other correlations are relatively low and appear to be within the acceptable ranges, except for the measures of trade credit and asset turnover which are by definition closely related.

Appendix 3.C presents the time series plots of the correlation averages across firms. The time series plots show that the correlations between leverage and firm characteristics changes over time. Although there is a general negative correlation between leverage and R&D, the time series plots of the correlations in Appendix 3.C shows that the negative correlation increased from 1987 to 2002, with a marked decrease from 2003 to 2011, and an increase thereafter. The decrease in the correlation suggests a change in risk aversion to financing R&D with debt. There is a general increase in the correlations between leverage and capital expenditure, except for short-term debt and total liabilities. This shows that firms are increasingly depending on

[27] Falato et al. (2013) presents a model showing that the rising intangible capital is the main factor causing the shrinkage in corporate debt and the secular increases in cash holdings.

[28] Several studies in the US report marked increases in cash holdings (e.g., Bates et al., 2009; Brown and Petersen, 2011; Foley et al., 2007).

[29] Although the literature does not provide a guidance on the threshold that defines a high correlation, this thesis implements a sensitivity analysis that involves dropping one of the variables in case there is a very high pair-wise correlation.

debt, in particular, long-term debt to finance further investments.

On average, Panel A in Appendix 3.C shows that the correlations between R&D and leverage are increasing up to early 2000s, thereafter, they decrease until the onset of the recent crisis, afterwhich, they increase again. Although capital expenditure is generally positively related with leverage, it is negatively related with total liabilities. Similar changes are also observable on the annual time series plots of the correlations (Appendix 3.C) between leverage variables and other factors (size, tangible assets, intangible assets, growth, profit, non-debt tax shield, asset turnover, volatility). These changes suggests that the relationship between leverage variables and firm characteristics changes over time.

The next section presents a discussion of the methodology used for the empirical analyses in Chapters 4, 5 and 6.

3.5 Methodology

This section provides a brief generic description of the models and estimation techniques used in the analyses in this thesis. More specific and detailed descriptions are provided in each of the subsequent three empirical chapters (Chapters 4, 5 and 6).

The empirical analyses in this thesis use a combination of ordinary least squares with fixed effects (OLS FE thereon) and system Generalised Method of Moments (system GMM thereon) as the main estimation techniques.[30] However, in order to ensure the robustness of the results and facilitate comparison with prior studies, results using other estimation techniques are also presented in the appendices where applicable.[31]

[30] Several empirical studies in corporate finance use similar estimation techniques (e.g., Byoun, 2008; Brav, 2009; Dang, 2013b; Faulkender et al., 2008; Flannery and Hankins, 2013; Huang and Ritter, 2009; Oztekin and Flannery, 2012).

[31] The appendices present estimation results using ordinary least squares (OLS thereon) (Dang, 2013a; Dang et al., 2014a; Ghaly et al., 2015; Love et al., 2007), Anderson Hsiao Instrumental Variables (AH IV thereon) (Dang et al., 2014a), Instrumental Variable Generalised Method of Moments (IV GMM thereon) (Baum et al., 2006), Difference Generalised Method of Moments (DIFF GMM thereon) (Dang et al., 2012, 2014a) and Fractional Dependent Variable (DPF thereon) (Elsas and Florysiak, 2013).

In Chapter 4, the probability of issuing or retiring debt and equity is estimated using probit regressions with a binary dependent variable that is equal one if the event occurs and zero otherwise (e.g., Hovakimian et al., 2001; Hovakimian and Vulanovic, 2010).

Using panel data allows the modelling of cross-sectional dynamics over time while simultaneously controlling for the potential endogeneity of the variables used. The simultaneity bias and autoregressive terms in dynamic panel data models render OLS estimates biased and inconsistent (see, Kiviet, 1995), hence, the use of instrumental variable estimating techniques. However, Stock et al. (2002) highlight that good instruments are difficult to find and, where available, the instruments may be weak, resulting in misleading inferences. The analyses in this thesis use system GMM estimation techniques proposed by Arellano and Bover (1995) and Blundell and Bond (1998). These are implemented by the command '*xtabond2*' in Stata. The '*xtabond2*' was developed by Roodman (2006).

The system GMM estimation techniques use all moment conditions by combining equations estimated in levels with those estimated in differences to increase efficiency (see, Blundell and Bond, 1998). Further, the techniques remove unobserved firm specific effects, potential endogenity problems and controls for heterogeneity across firms.[32] The second to the fifth lags are used as instruments for the endogenous variables in the analyses in this thesis in order to mitigate instrument proliferation ("too many instruments") and its consequences, which include over-fitting of endogenous variables, bias of estimates, and weakening of the Sargan-Hansen test. The Hansen-Sargan test (*J test*) for over-identifying restrictions (at the conventional 5% level), and the *m2* test for the non-existence of the second order serial correlation in the differenced residuals are used to test whether the models are correctly specified and the instruments used are valid (Arellano and Bover, 1995; Blundell and Bond, 1998). The *J statistic* for over-identifying restrictions is asymptotically distributed

[32] Endogeneity problems arise due to simultaneity, omitted variables, measurement errors, and auto-regression with auto-correlated errors.

as chi-square with degrees of freedom equal to the difference between the number of instruments and the number of parameters. The test for second-order serial correlation of the residuals in the differenced equations (*m2*) is asymptotically normally distributed under the null of no second-order serial correlation of differenced residuals.

Further detail of the methodology is provided in each chapter given that they differ depending on the particular hypotheses being investigated. The following section presents a summary and an overall structure of the remaining chapters.

3.6 Summary

This chapter presents an overview of the data, sample composition and the methodology used. The data shows that leverage has remained largely persistent and increasing on average, despite the decrease in fixed capital expenditure and tangible assets, and the increase in R&D and intangible assets. This suggests that an increasing proportion of debt is financing intangible assets as shown by the increase in the debt-to-collateral ratios. Comparisons of the basic statistics show that non-innovative firms use relatively more leverage than innovative firms, with the differences in mean, being significant on total debt, net-debt and long-term debt. A further examination of the time series plots of leverage shows that leverage of innovative and non-innovative firms exhibits similar trends, except during the period from 2000 to 2013, when non-innovative firms have relatively more leverage than innovative firms. This result suggests that innovative firms are able to access debt financing despite the literature predicting that they should use more(less) equity (debt) financing. On average, the basic statistics and times series plots of leverage suggests the need to examine the financing decisions of innovative and non-innovative firms in order to gain a better understanding of the changing interdependence of financing and investment decisions.

The rest of the this thesis are structured as follows: Chapter 4 presents the results of the comparisons of the financing structure between innovative and non-innovative firms, Chapter 5 presents the results of the differences in leverage adjustments between innovative and non-innovative firms, Chapter 6 presents the results of the differences in trade credit adjustments between innovative and non-innovative firms, and Chapter 7 concludes by presenting an overview of the main findings of the thesis, limitations and directions for future research.

Appendices to Chapter 3

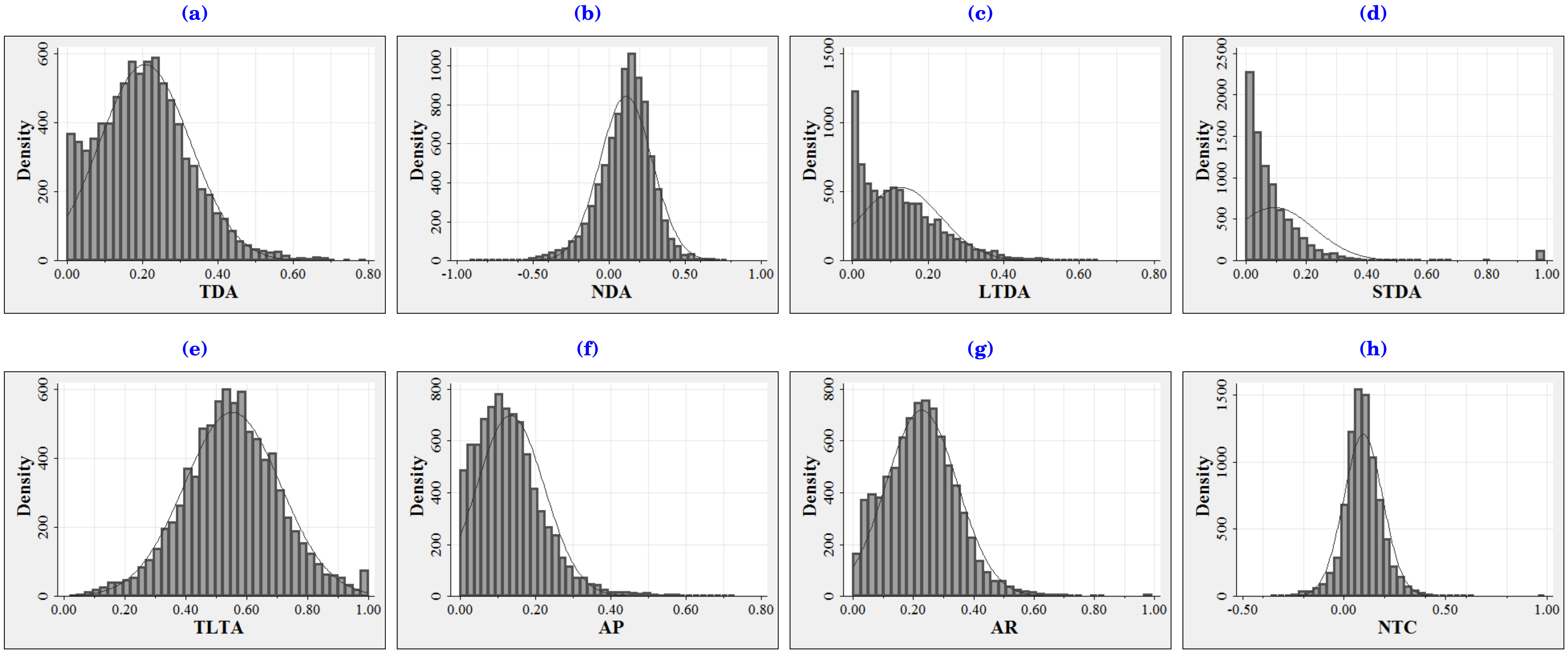
Appendix 3.A Sample structure by year

The table presents the number of companies (N), number of firm-year observations, percentage of sample and the cumulative percentage of sample over time. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK from the main official list of the London Stock Exchange over the period from 1987 to 2013. The data is drawn from Worldscope through Datastream.

	ALL			NIN			INN		
Year	N	% of Sample	Cumulative % of Sample	N	% of Sample	Cumulative % of Sample	N	% of Sample	Cumulative % of Sample
1987	161	2%	2%	50	2%	2%	111	2%	2%
1988	268	3%	5%	113	3%	5%	155	3%	5%
1989	315	4%	9%	143	4%	9%	172	3%	9%
1990	411	5%	14%	177	5%	15%	234	5%	13%
1991	439	5%	19%	193	6%	20%	246	5%	18%
1992	449	5%	24%	197	6%	26%	252	5%	23%
1993	463	6%	30%	201	6%	33%	262	5%	28%
1994	471	6%	35%	201	6%	39%	270	5%	33%
1995	447	5%	41%	188	6%	44%	259	5%	39%
1996	431	5%	46%	180	5%	50%	251	5%	43%
1997	419	5%	51%	171	5%	55%	248	5%	48%
1998	382	5%	55%	153	5%	60%	229	4%	53%
1999	323	4%	59%	122	4%	63%	201	4%	57%
2000	281	3%	63%	106	3%	66%	175	3%	60%
2001	277	3%	66%	100	3%	69%	177	3%	64%
2002	275	3%	69%	93	3%	72%	182	4%	67%
2003	265	3%	72%	95	3%	75%	170	3%	71%
2004	264	3%	76%	93	3%	78%	171	3%	74%
2005	255	3%	79%	91	3%	81%	164	3%	77%
2006	244	3%	81%	85	3%	83%	159	3%	80%
2007	242	3%	84%	87	3%	86%	155	3%	83%
2008	249	3%	87%	89	3%	89%	160	3%	86%
2009	251	3%	90%	92	3%	91%	159	3%	90%
2010	237	3%	93%	86	3%	94%	151	3%	93%
2011	214	3%	96%	79	2%	96%	135	3%	95%
2012	195	2%	98%	68	2%	98%	127	2%	98%
2013	168	2%	100%	51	2%	100%	117	2%	100%

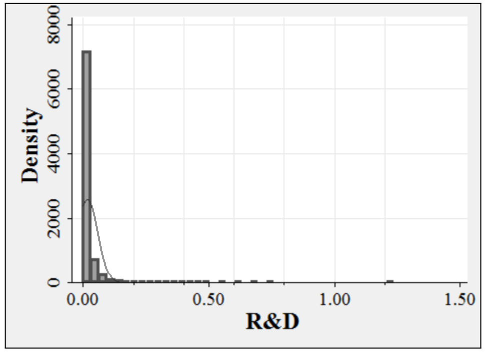
Appendix 3.B Variable distributions

The figures presents histograms for the variables used. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream.



Appendix 3.B Variable distributions (continued)

(i)



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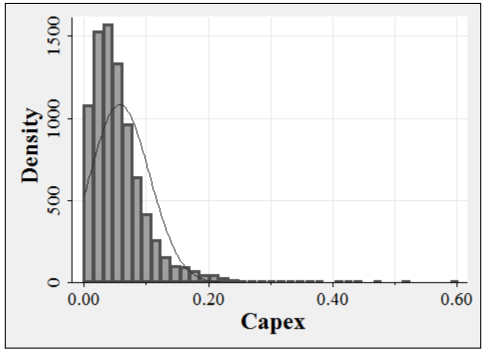

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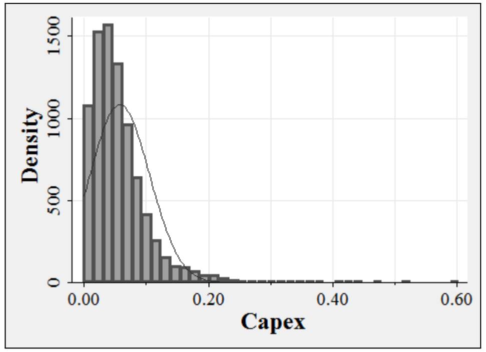

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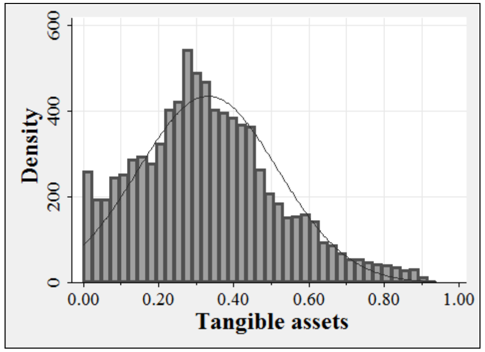

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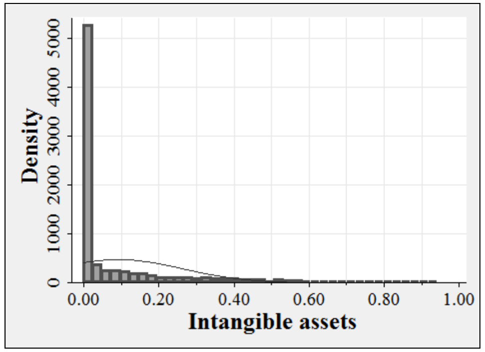

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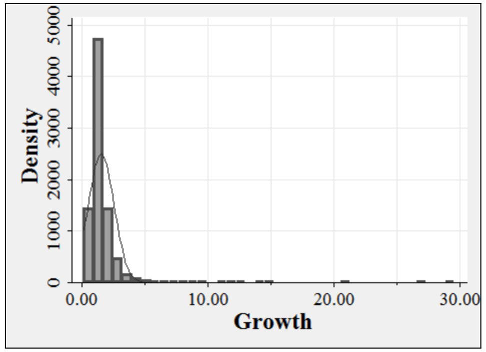
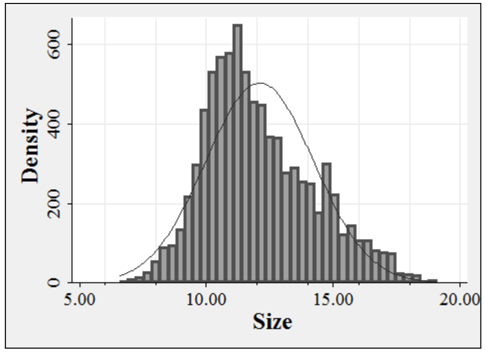
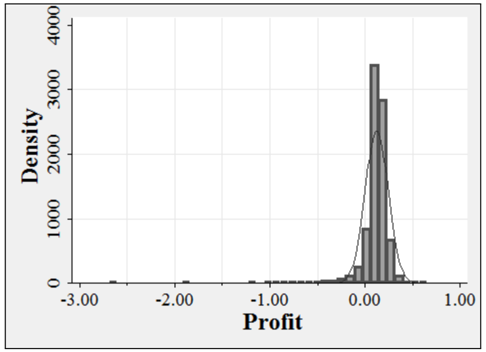


(o)



Appendix 3.B Variable distributions (continued)

(p)



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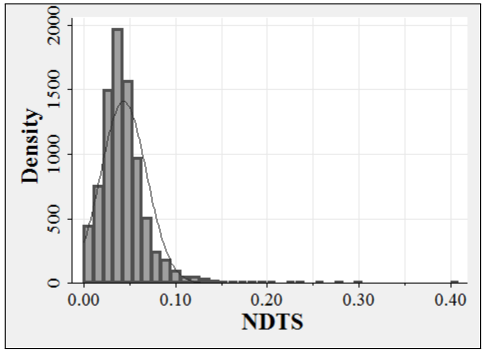

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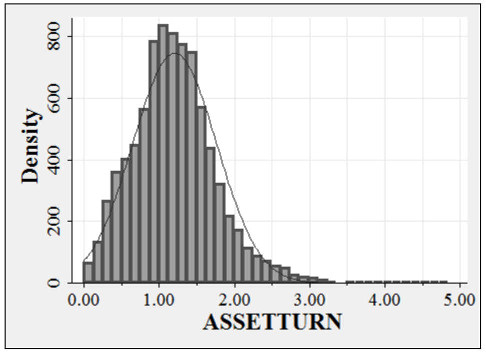

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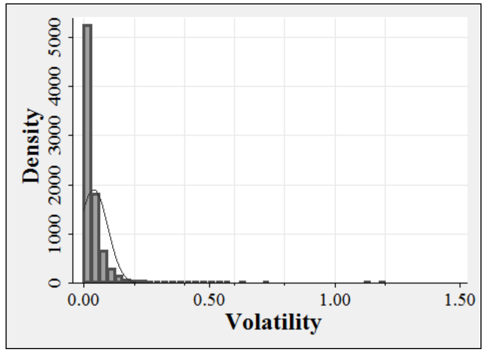

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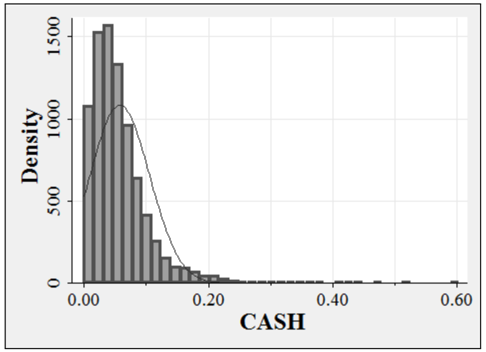

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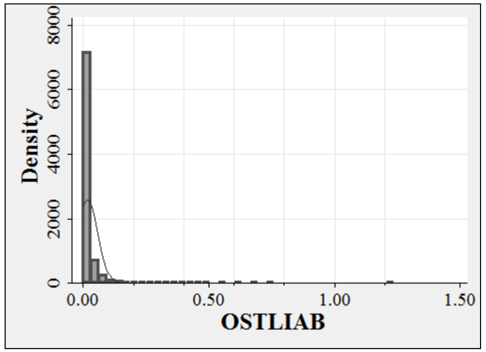
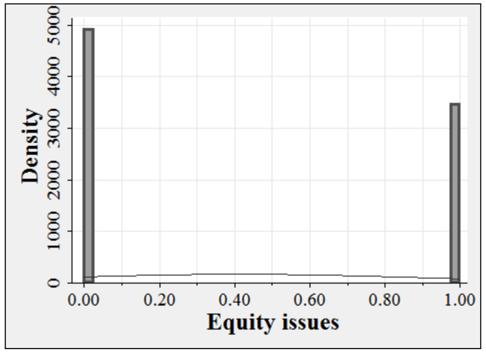


Appendix 3.B Variable distributions (continued)

(v)



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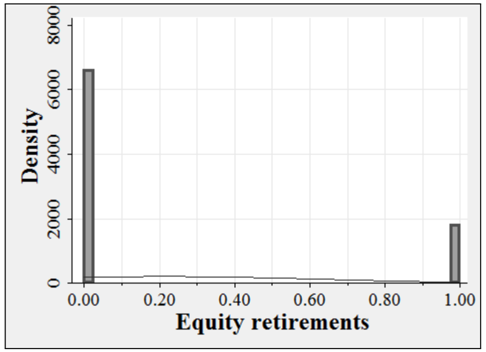
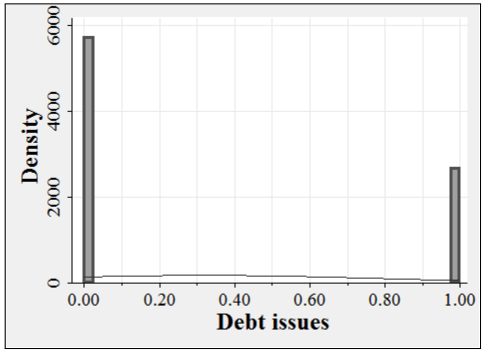
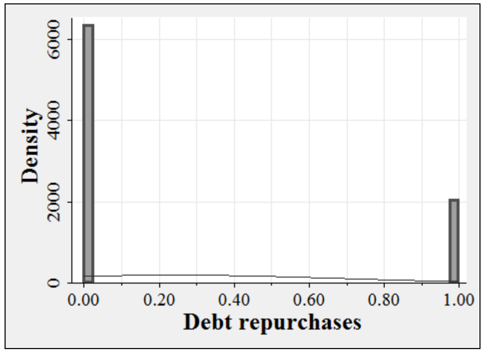


(x)



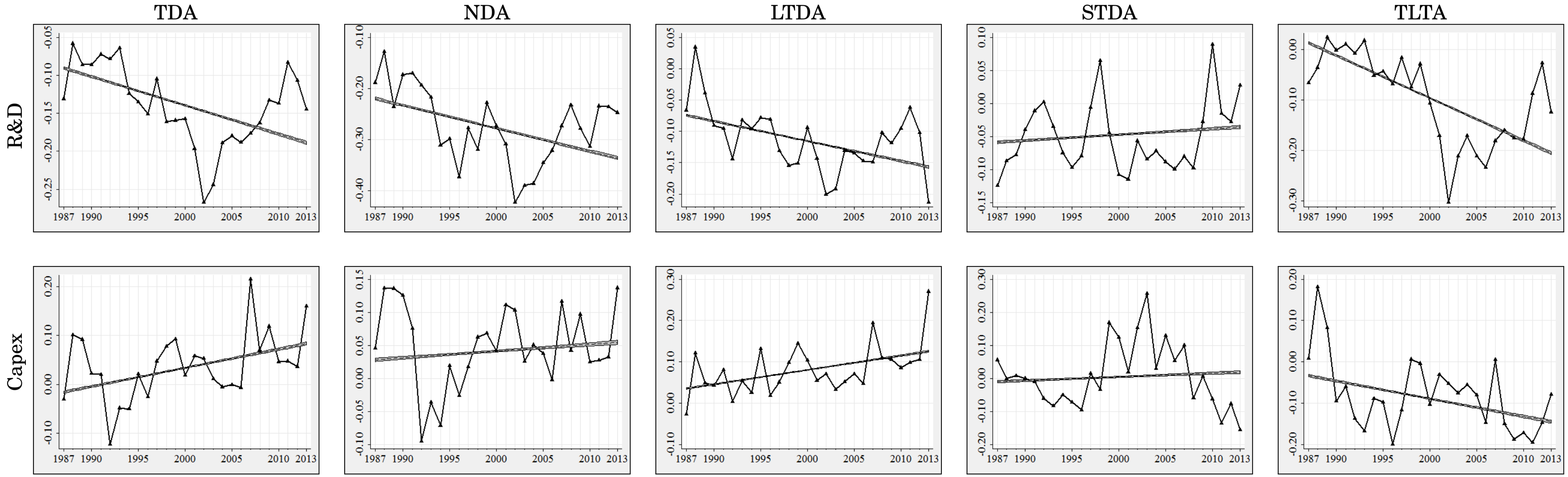
(y)



Appendix 3.C Correlations by year

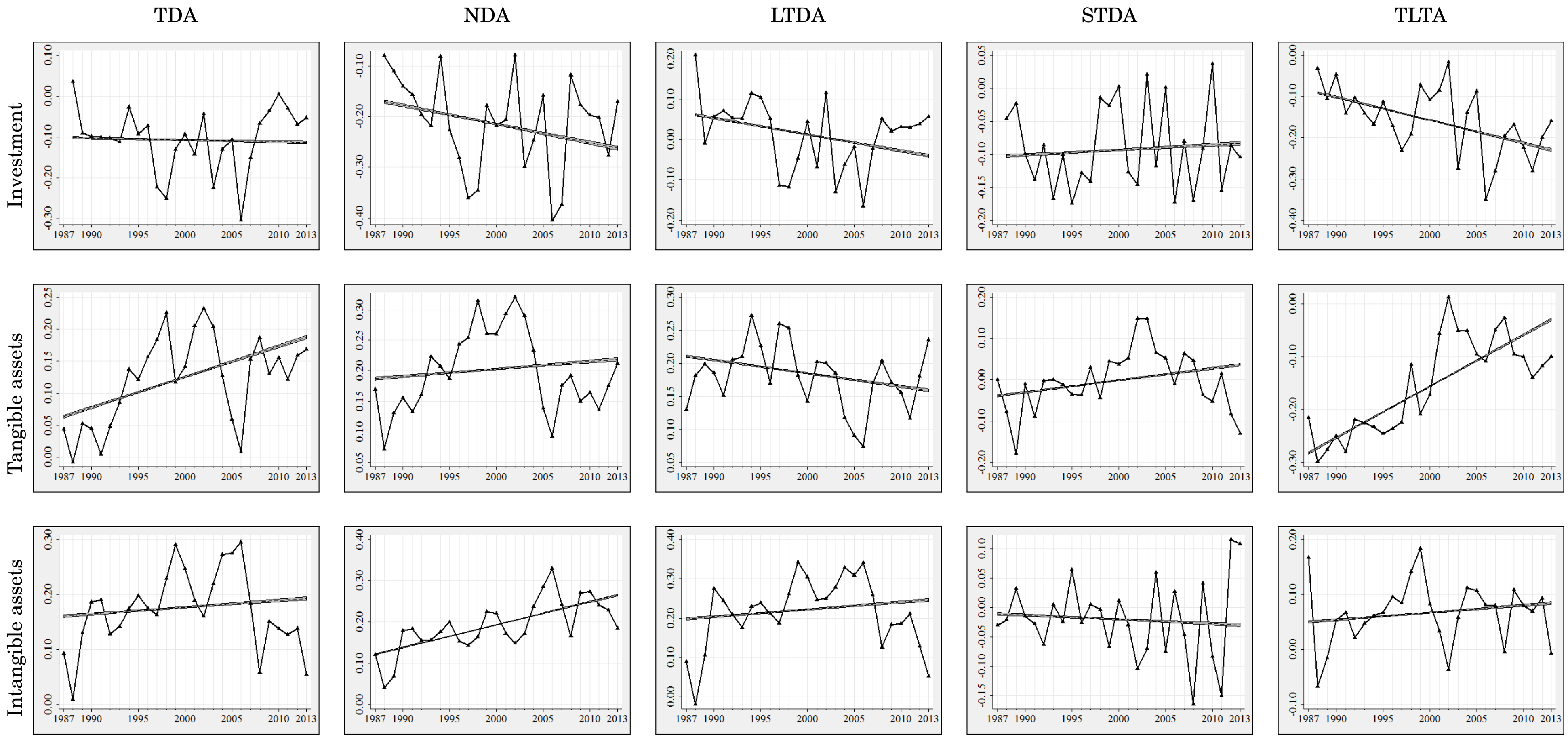
The table presents correlations between the variables used for each year. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK from the main official list of the London Stock Exchange over the period from 1987 to 2013. The data is drawn from Worldscope through Datastream. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1th and 99th percentiles.

Panel A: Leverage and firm characteristics



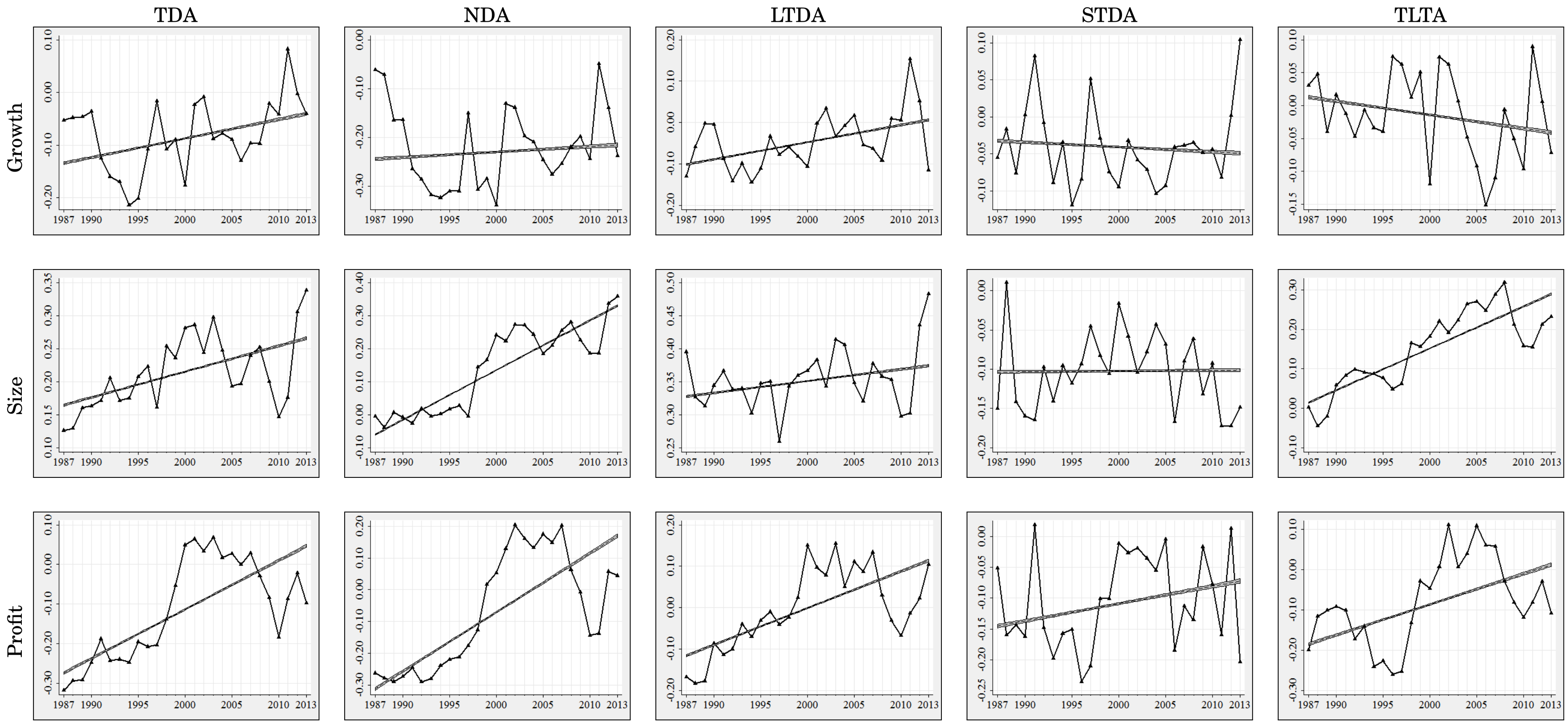
Appendix 3.C Correlations by year (continued)

Panel A: Leverage and firm characteristics



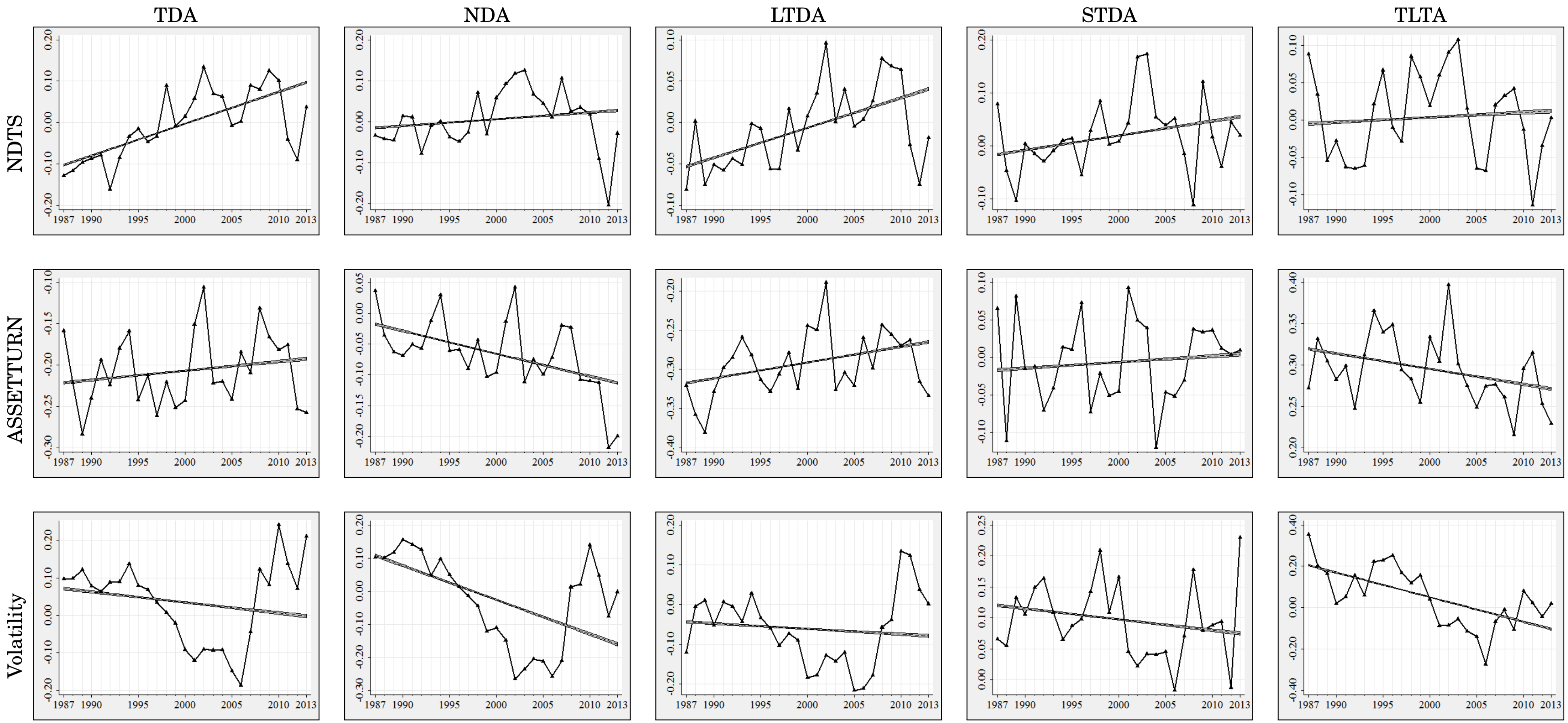
Appendix 3.C Correlations by year (continued)

Panel A: Leverage and firm characteristics



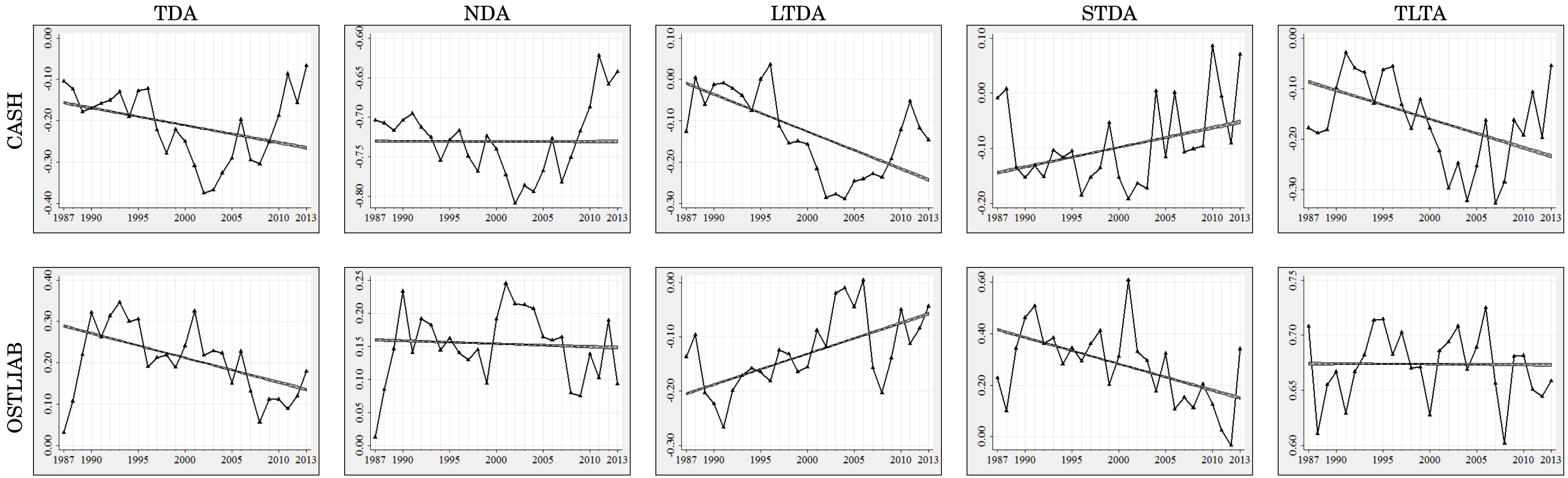
Appendix 3.C Correlations by year (continued)

Panel A: Leverage and firm characteristics



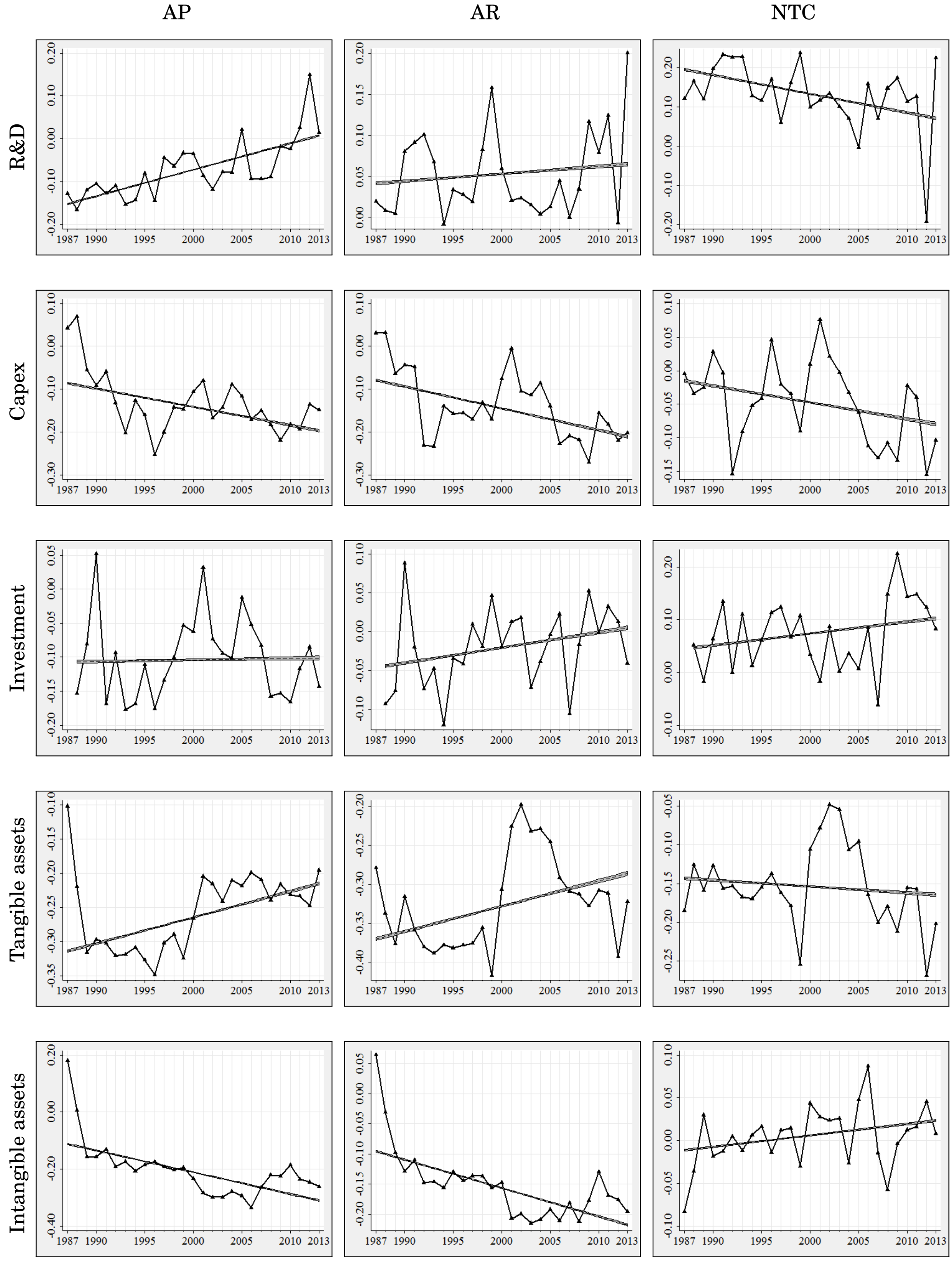
Appendix 3.C Correlations by year (continued)

Panel A: Leverage and firm characteristics



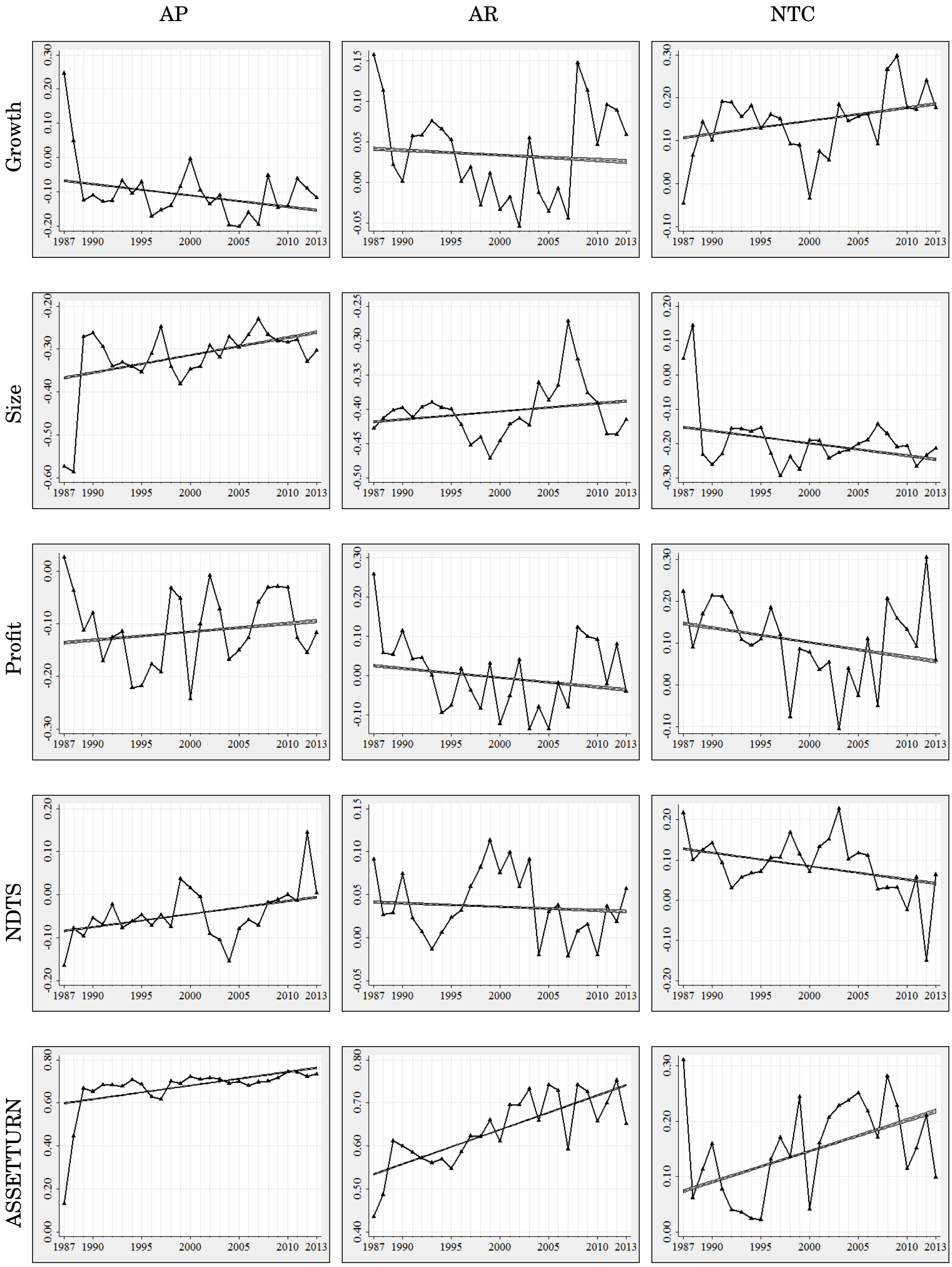
Appendix 3.C Correlations by year (continued)

Panel B: Trade credit and firm characteristics



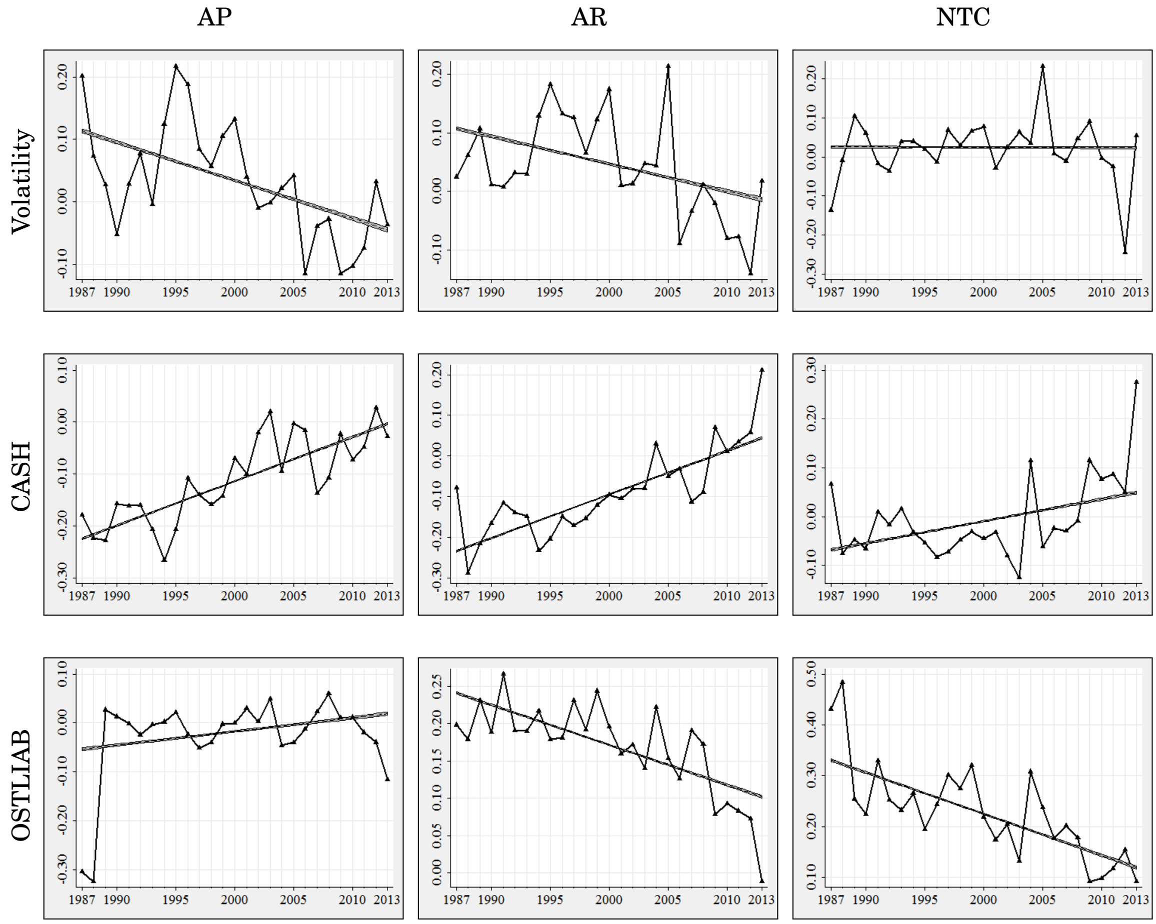
Appendix 3.C Correlations by year (continued)

Panel B: Trade credit and firm characteristics



Appendix 3.C Correlations by year (continued)

Panel B: Trade credit and firm characteristics



Appendix 3.D Leverage, trade credit and firm characteristics by year

The table presents the mean of leverage, trade credit and firm characteristics for each year. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK from the main official list of the London Stock Exchange over the period from 1987 to 2013. The data is drawn from Worldscope through Datastream. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1^{th} and 99^{th} percentiles.

	TDA			NDA			LTDA			STDA			TLTA			AP		
YEAR	ALL	NIN	INN	ALL	NIN	INN	ALL	NIN	INN	ALL	NIN	INN	ALL	NIN	INN	ALL	NIN	INN
1987	0.155	0.169	0.148	0.061	0.116	0.035	0.083	0.087	0.082	0.071	0.082	0.067	0.527	0.545	0.519	0.062	0.087	0.051
1988	0.167	0.177	0.161	0.085	0.109	0.067	0.077	0.071	0.082	0.007	0.005	0.008	0.543	0.550	0.538	0.116	0.141	0.097
1989	0.188	0.191	0.186	0.106	0.128	0.087	0.086	0.087	0.085	0.010	0.007	0.012	0.551	0.550	0.553	0.158	0.169	0.148
1990	0.210	0.213	0.207	0.127	0.148	0.111	0.082	0.097	0.071	0.013	0.012	0.014	0.558	0.545	0.568	0.149	0.152	0.147
1991	0.214	0.224	0.207	0.129	0.157	0.106	0.087	0.084	0.089	0.015	0.015	0.014	0.555	0.548	0.561	0.144	0.152	0.137
1992	0.213	0.216	0.211	0.119	0.140	0.102	0.068	0.063	0.072	0.017	0.022	0.013	0.560	0.548	0.569	0.143	0.149	0.139
1993	0.200	0.196	0.204	0.097	0.111	0.086	0.073	0.066	0.078	0.015	0.021	0.010	0.550	0.530	0.566	0.146	0.153	0.141
1994	0.187	0.183	0.189	0.087	0.110	0.070	0.077	0.061	0.089	0.015	0.021	0.011	0.557	0.542	0.569	0.155	0.167	0.146
1995	0.193	0.189	0.196	0.101	0.126	0.083	0.083	0.071	0.091	0.015	0.020	0.012	0.573	0.555	0.585	0.162	0.173	0.153
1996	0.191	0.191	0.190	0.099	0.122	0.083	0.088	0.067	0.103	0.014	0.017	0.012	0.572	0.568	0.575	0.161	0.175	0.150
1997	0.192	0.194	0.191	0.094	0.123	0.075	0.082	0.064	0.094	0.015	0.021	0.011	0.575	0.575	0.575	0.153	0.169	0.142
1998	0.203	0.192	0.210	0.105	0.123	0.093	0.081	0.071	0.088	0.030	0.027	0.032	0.576	0.572	0.579	0.149	0.166	0.138
1999	0.218	0.214	0.221	0.126	0.140	0.117	0.091	0.069	0.105	0.057	0.043	0.066	0.564	0.559	0.567	0.138	0.155	0.128
2000	0.220	0.213	0.225	0.126	0.143	0.115	0.077	0.067	0.084	0.091	0.075	0.101	0.554	0.548	0.557	0.137	0.158	0.124
2001	0.231	0.242	0.225	0.144	0.174	0.127	0.079	0.071	0.083	0.122	0.100	0.136	0.548	0.556	0.543	0.128	0.150	0.115
2002	0.227	0.240	0.220	0.134	0.164	0.118	0.074	0.056	0.084	0.141	0.112	0.156	0.560	0.580	0.551	0.121	0.142	0.111
2003	0.218	0.229	0.212	0.127	0.157	0.111	0.083	0.071	0.091	0.150	0.134	0.159	0.565	0.586	0.554	0.127	0.144	0.118
2004	0.208	0.222	0.200	0.108	0.150	0.085	0.079	0.059	0.091	0.163	0.151	0.171	0.543	0.568	0.529	0.120	0.138	0.110
2005	0.207	0.225	0.196	0.106	0.153	0.080	0.072	0.055	0.082	0.180	0.166	0.189	0.560	0.593	0.542	0.122	0.141	0.111
2006	0.207	0.229	0.195	0.107	0.159	0.080	0.077	0.050	0.092	0.218	0.221	0.217	0.546	0.583	0.527	0.116	0.126	0.110
2007	0.220	0.228	0.215	0.117	0.138	0.105	0.068	0.056	0.076	0.237	0.242	0.234	0.535	0.538	0.533	0.106	0.102	0.108
2008	0.232	0.237	0.230	0.142	0.149	0.137	0.070	0.053	0.080	0.241	0.229	0.249	0.553	0.551	0.554	0.106	0.112	0.102
2009	0.223	0.234	0.217	0.131	0.158	0.116	0.075	0.060	0.084	0.259	0.257	0.260	0.544	0.548	0.541	0.097	0.098	0.097
2010	0.203	0.226	0.190	0.104	0.148	0.079	0.074	0.056	0.085	0.258	0.261	0.255	0.516	0.540	0.502	0.102	0.099	0.103
2011	0.196	0.207	0.189	0.109	0.138	0.092	0.072	0.057	0.082	0.259	0.255	0.262	0.507	0.526	0.496	0.107	0.105	0.108
2012	0.204	0.209	0.201	0.121	0.150	0.106	0.086	0.072	0.094	0.274	0.294	0.264	0.516	0.532	0.508	0.108	0.108	0.107
2013	0.212	0.233	0.201	0.120	0.145	0.109	0.078	0.070	0.082	0.272	0.281	0.268	0.516	0.534	0.508	0.104	0.103	0.105
TOTAL	0.205	0.209	0.202	0.112	0.137	0.095	0.077	0.067	0.084	0.092	0.084	0.097	0.553	0.554	0.552	0.134	0.147	0.125

Appendix 3.D Firm characteristics by year (continued)

	OSTLIAB			CASH			R&D			CAPEX			TANGIBLE			INTANGIBLE		
YEAR	ALL	NIN	INN	ALL	NIN	INN	ALL	NIN	INN	ALL	NIN	INN	ALL	NIN	INN	ALL	NIN	INN
1987	0.38	0.36	0.39	0.10	0.06	0.11	0.01	0.00	0.01	0.07	0.07	0.06	0.34	0.34	0.34	0.00	0.01	0.00
1988	0.34	0.32	0.36	0.08	0.07	0.10	0.01	0.00	0.01	0.07	0.08	0.07	0.34	0.35	0.33	0.01	0.01	0.01
1989	0.30	0.28	0.31	0.09	0.07	0.10	0.01	0.00	0.01	0.08	0.09	0.07	0.34	0.35	0.34	0.01	0.01	0.01
1990	0.30	0.28	0.31	0.08	0.07	0.10	0.01	0.00	0.02	0.09	0.09	0.08	0.36	0.36	0.36	0.01	0.01	0.01
1991	0.30	0.28	0.32	0.09	0.07	0.10	0.01	0.00	0.02	0.08	0.08	0.07	0.37	0.37	0.37	0.02	0.02	0.01
1992	0.30	0.28	0.32	0.10	0.08	0.11	0.01	0.00	0.02	0.05	0.05	0.06	0.37	0.37	0.37	0.02	0.02	0.01
1993	0.29	0.26	0.32	0.11	0.09	0.12	0.01	0.00	0.02	0.05	0.05	0.05	0.36	0.36	0.36	0.02	0.02	0.01
1994	0.30	0.27	0.32	0.10	0.08	0.12	0.01	0.00	0.02	0.05	0.05	0.05	0.36	0.36	0.35	0.02	0.02	0.01
1995	0.30	0.27	0.32	0.09	0.07	0.11	0.01	0.00	0.02	0.05	0.05	0.05	0.35	0.35	0.35	0.02	0.02	0.01
1996	0.30	0.28	0.31	0.09	0.07	0.10	0.02	0.00	0.03	0.06	0.06	0.07	0.36	0.36	0.36	0.01	0.02	0.01
1997	0.31	0.28	0.32	0.10	0.08	0.12	0.02	0.00	0.03	0.06	0.06	0.07	0.36	0.36	0.36	0.02	0.02	0.01
1998	0.30	0.29	0.32	0.10	0.07	0.12	0.02	0.00	0.03	0.06	0.06	0.07	0.36	0.36	0.36	0.03	0.03	0.03
1999	0.29	0.27	0.30	0.09	0.07	0.10	0.02	0.00	0.03	0.06	0.07	0.06	0.37	0.38	0.36	0.06	0.04	0.07
2000	0.28	0.26	0.30	0.09	0.07	0.11	0.02	0.00	0.03	0.06	0.06	0.06	0.34	0.35	0.33	0.09	0.08	0.10
2001	0.28	0.27	0.30	0.09	0.06	0.10	0.02	0.00	0.03	0.06	0.06	0.06	0.33	0.35	0.31	0.12	0.10	0.14
2002	0.30	0.29	0.30	0.09	0.07	0.10	0.02	0.00	0.03	0.05	0.05	0.05	0.31	0.34	0.30	0.14	0.11	0.16
2003	0.30	0.29	0.30	0.09	0.07	0.10	0.02	0.00	0.04	0.04	0.04	0.04	0.30	0.32	0.29	0.15	0.13	0.16
2004	0.28	0.28	0.28	0.10	0.07	0.12	0.02	0.00	0.04	0.05	0.04	0.05	0.29	0.31	0.28	0.16	0.15	0.17
2005	0.29	0.29	0.29	0.10	0.08	0.12	0.02	0.00	0.04	0.04	0.05	0.04	0.29	0.31	0.27	0.18	0.17	0.19
2006	0.29	0.30	0.28	0.10	0.07	0.12	0.02	0.00	0.04	0.05	0.05	0.05	0.27	0.29	0.25	0.22	0.22	0.22
2007	0.28	0.27	0.28	0.10	0.10	0.11	0.02	0.00	0.03	0.05	0.05	0.04	0.27	0.30	0.26	0.24	0.24	0.23
2008	0.28	0.27	0.28	0.10	0.09	0.10	0.02	0.00	0.03	0.05	0.05	0.04	0.27	0.30	0.26	0.24	0.23	0.25
2009	0.28	0.27	0.28	0.10	0.08	0.11	0.02	0.00	0.03	0.05	0.06	0.05	0.28	0.31	0.26	0.26	0.26	0.26
2010	0.26	0.26	0.26	0.10	0.09	0.11	0.02	0.00	0.03	0.04	0.04	0.04	0.27	0.31	0.25	0.26	0.26	0.26
2011	0.26	0.27	0.25	0.09	0.08	0.10	0.02	0.00	0.03	0.04	0.04	0.04	0.27	0.32	0.25	0.26	0.26	0.26
2012	0.25	0.26	0.25	0.09	0.07	0.10	0.02	0.00	0.03	0.05	0.04	0.05	0.27	0.29	0.26	0.27	0.29	0.26
2013	0.25	0.26	0.25	0.09	0.08	0.10	0.02	0.00	0.03	0.05	0.05	0.05	0.27	0.30	0.26	0.27	0.28	0.27
TOTAL	0.29	0.28	0.30	0.09	0.07	0.11	0.02	0.00	0.03	0.06	0.06	0.06	0.33	0.34	0.32	0.09	0.08	0.10

Appendix 3.D Firm characteristics by year (continued)

	SIZE			GROWTH			PROFIT			NDTS			VOLATILITY			ASSETTURN		
YEAR	ALL	NIN	INN	ALL	NIN	INN	ALL	NIN	INN	ALL	NIN	INN	ALL	NIN	INN	ALL	NIN	INN
1987	12.35	11.57	12.69	1.67	1.80	1.62	0.17	0.16	0.18	0.04	0.03	0.04	0.02	0.02	0.02	1.28	1.31	1.27
1988	11.69	11.11	12.09	1.49	1.49	1.49	0.17	0.17	0.18	0.04	0.04	0.04	0.02	0.02	0.02	1.33	1.36	1.30
1989	11.65	11.17	12.03	1.48	1.43	1.53	0.17	0.17	0.17	0.04	0.04	0.04	0.03	0.03	0.03	1.30	1.34	1.27
1990	11.93	11.26	12.42	1.27	1.20	1.33	0.16	0.15	0.17	0.04	0.04	0.04	0.03	0.03	0.02	1.31	1.32	1.30
1991	11.84	11.16	12.35	1.33	1.20	1.43	0.13	0.12	0.14	0.04	0.04	0.04	0.03	0.04	0.03	1.29	1.31	1.28
1992	11.80	11.12	12.31	1.36	1.18	1.49	0.12	0.11	0.13	0.04	0.04	0.04	0.03	0.04	0.03	1.25	1.26	1.24
1993	11.81	11.14	12.31	1.50	1.33	1.63	0.12	0.10	0.13	0.04	0.04	0.04	0.03	0.04	0.03	1.26	1.25	1.27
1994	11.83	11.16	12.33	1.61	1.45	1.72	0.13	0.12	0.14	0.04	0.04	0.04	0.04	0.04	0.03	1.30	1.31	1.29
1995	11.92	11.23	12.43	1.61	1.39	1.77	0.13	0.12	0.14	0.04	0.04	0.04	0.04	0.04	0.04	1.32	1.35	1.30
1996	11.89	11.27	12.34	1.71	1.46	1.89	0.13	0.11	0.14	0.04	0.04	0.05	0.04	0.04	0.04	1.38	1.39	1.37
1997	11.89	11.39	12.24	1.71	1.46	1.88	0.14	0.12	0.15	0.04	0.04	0.05	0.04	0.03	0.04	1.36	1.38	1.35
1998	11.95	11.43	12.31	1.59	1.34	1.75	0.13	0.13	0.14	0.05	0.04	0.05	0.05	0.05	0.05	1.30	1.38	1.25
1999	12.04	11.57	12.35	1.59	1.29	1.78	0.12	0.11	0.13	0.05	0.05	0.05	0.05	0.05	0.05	1.22	1.29	1.18
2000	12.01	11.65	12.25	1.76	1.36	2.02	0.11	0.09	0.12	0.05	0.04	0.05	0.05	0.05	0.05	1.19	1.26	1.15
2001	12.06	11.68	12.29	1.39	1.18	1.52	0.10	0.10	0.10	0.05	0.05	0.05	0.06	0.06	0.06	1.17	1.24	1.13
2002	12.07	11.72	12.27	1.34	1.16	1.43	0.08	0.09	0.08	0.05	0.05	0.06	0.06	0.04	0.06	1.14	1.23	1.10
2003	12.08	11.81	12.24	1.43	1.30	1.51	0.09	0.11	0.08	0.05	0.05	0.06	0.05	0.04	0.05	1.17	1.22	1.14
2004	12.15	11.80	12.35	1.59	1.36	1.72	0.12	0.11	0.12	0.05	0.04	0.05	0.05	0.04	0.05	1.14	1.19	1.11
2005	12.15	11.87	12.32	1.75	1.48	1.92	0.10	0.10	0.11	0.04	0.04	0.05	0.04	0.03	0.04	1.10	1.15	1.07
2006	12.20	12.00	12.31	1.82	1.53	1.98	0.11	0.10	0.11	0.04	0.04	0.04	0.04	0.04	0.04	1.06	1.04	1.07
2007	12.17	11.85	12.36	1.77	1.50	1.93	0.10	0.09	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.98	0.89	1.03
2008	12.25	12.05	12.37	1.23	1.02	1.35	0.08	0.07	0.08	0.04	0.04	0.04	0.05	0.05	0.05	0.97	0.97	0.97
2009	12.24	12.11	12.32	1.33	1.10	1.47	0.07	0.05	0.08	0.05	0.04	0.05	0.05	0.06	0.05	0.97	0.92	1.00
2010	12.34	12.21	12.43	1.51	1.22	1.69	0.10	0.08	0.11	0.04	0.04	0.05	0.05	0.05	0.04	0.95	0.90	0.99
2011	12.44	12.30	12.53	1.40	1.14	1.56	0.11	0.10	0.12	0.04	0.04	0.05	0.04	0.05	0.04	0.98	0.96	1.00
2012	12.63	12.69	12.60	1.50	1.22	1.65	0.10	0.09	0.11	0.04	0.04	0.05	0.04	0.05	0.04	0.98	0.94	1.00
2013	12.79	12.89	12.73	1.72	1.46	1.84	0.10	0.07	0.12	0.05	0.05	0.05	0.04	0.04	0.03	0.96	0.92	0.98
TOTAL	12.02	11.53	12.34	1.53	1.33	1.66	0.12	0.11	0.13	0.04	0.04	0.05	0.04	0.04	0.04	1.20	1.23	1.19

Chapter 4

Financing Structure: The Case of Innovative versus Non-Innovative Firms

4.1 Summary

This chapter examines the differences in financing decisions of innovative and non-innovative firms in the UK over the period 1987-2013. The results of the analysis show that there is a significant increase in R&D and decrease in collateral values over time, which has not been matched by a corresponding decrease in leverage. Leverage has remained persistent with an upward drift, which suggests that firms in the UK are able to access debt financing despite the decrease in collateral values. The results show significant time variation in the relationship between financing and investment. Comparisons show that most of the determinants of capital structure have similar effects for innovative and non-innovative firms, except on capital expenditure, tangible assets and intangible assets that significantly differ across the two firm groups. Intangible assets and tangible assets have a significantly higher positive effect on debt for innovative firms, while capital expenditure is only significant for non-innovative firms. The results also show that leverage increases with intangible assets in a similar way as tangible assets and, more importantly, for innovative firms with low collateral values. These results suggest that innovative firms are able to access debt financing and that examining heterogeneity arising from corporate investments is important in understanding the observed variations in capital structure.

4.2 Introduction

What is the effect of the increase in R&D expenditures on debt financing? Do innovative and non-innovative firms adopt different financing structures? The need to understand the financing of innovation, and how it differs from that of physical capital investments is increasingly becoming important as economies transit from manufacturing towards service and technology sectors.[1] This transition in corporate

[1]Several studies report marked changes in firm characteristics and industrial compositions. For example, Buera and Kaboski (2012) and Damodaran (2009) highlight the rising importance of the service and technology sectors in advanced economies in the post-1950s period. Fama and French (2004) and Fama and French (2005) report a surge in IPOs by young and new firms in the US over the past decades. Almeida et al. (2004), Chen and Chen (2012) and Moshirian et al. (2013) report marked decreases in investment-cash-flow sensitivity (ICFs). Similarly, US studies report secular increases in cash holdings (e.g., Acharya et al., 2007, 2012; Ang and Smedema, 2011; Bates et al., 2009).

investments over the recent decades is marked by a surge in R&D to levels that now match or exceed physical capital expenditure, and a fall in tangible assets, while intangible assets increase greatly. For example, Borisova and Brown (2013) report a fourfold (twofold) increase in R&D among young (mature) firms in the US from 5% (3.5%) in 1980 to 20% (8%) in 2001, with R&D falling (increasing) to 14.4% (9.3%) by 2008. In a study of R&D smoothing in the US, Brown and Petersen (2011) report similar increases in R&D from 2% for the period 1970-1981 to 6.3% for the period 1982-1993, with R&D rising to 10.3% over the period 1994-2006. Brown and Petersen (2011) also report a significant decrease in capital expenditure from 7.2% to 5.4% over the period from 1970 to 2006. Similarly, Brown et al. (2012) report that the mean of R&D (8.5%) of firms in Europe over the period 1995-2007 is larger than that of physical capital investment (5.8%). Falato et al. (2013) and Sporleder et al. (2002) report similar increases in R&D in the US. However, these marked changes in corporate investments and their implications on corporate decisions have been largely overlooked in the literature, with most research focusing on fixed capital investments. Yet, the upward trend in innovation and the decrease in fixed capital investments and tangible assets appear to be a long-term phenomena.

The relationship between financing and investment decisions is a classical issue in corporate finance, with Miller (1991) famously highlighting that managers should not worry about "second order self-correcting activities" such as capital structure. Similarly, Chava and Roberts (2008) and Stein (2003) highlight that the linkages between financing and real decisions (such as investment, employment) in the presence of market imperfections is rather ambiguous, even after decades of concerted research effort.[2] The high information asymmetry, susceptibility to asset substitution problems, longer investment horizons and low pledgeable values that charac-

[2] Empirical studies examining these relationships between investment and financial decisions are rather less developed as they often consider each corporate decision in isolation (Dang, 2011) or adopt a *ceteris paribus* approach (Dammon and Senbet, 1988), which tends to overlook the interdependence and simultaneity in corporate decisions. Results on the linkages between finance and investment are mixed, with one strand of the literature reporting significant or insignificant linkages (Mauer and Triantis, 1994), while the other either reports a positive (e.g., Lyandres and Zhdanov, 2005) or a negative relationship (e.g., Aivazian et al., 2005; Dang, 2011; DeAngelo and Masulis, 1980; Lang et al., 1996). These mixed results highlight the need for further research.

terise innovative investments make capital structure of "first order importance" to corporate decisions. Theory predicts that innovative investments should be financed with equity, as R&D generate intangible assets which are a poor form of collateral (see, Arrow, 1962; Nelson, 1959). Similarly, the stakeholder co-investment theory of Titman (1984) posits that firms with unique products are more likely to face binding constraints.[3] These predictions should result in innovative firms using less debt financing relative to non-innovative firms.

The control rights proposition posits that in as much as the covenants associated with debt affords closer monitoring of managers, the covenants inadvertently restrict strategic flexibility (the need to make regular interest and debt repayments) (O'Brien, 2003) and harm innovation (by requiring disclosure of proprietary information) (Buera and Kaboski, 2012). Furthermore, in the presence of information asymmetry, equity financing is costly as it often involves dilution of ownership (see, Aghion et al., 2004; O'Brien, 2003). According to David et al. (2008), debt financing in the form relational debt is a more appropriate form of financing for innovation, as relational lenders are concentrated (as opposed to fragmented transactional lenders) and have information about the collateral values of innovation. Similarly, Stroebel (2015) presents a model which shows that integrated lenders with a comparative advantage in terms of information about collateral values give more loans (for innovative projects) at relatively lower interest rates than non-integrated lenders. Chava et al. (2013) also report results that lender expertise is important to the financing of

[3] Borisova and Brown (2013), Brown and Petersen (2009), Brown and Petersen (2011), Brown et al. (2012), Buera and Kaboski (2012), Hall (2009), Itenberg and Stangebye (2013) and Moshirian et al. (2013) report that the unique features of innovative investments (high information asymmetry issues, asset substitution problems and low collateral values) subjects firms to binding credit constraints. Consistent with these predictions, several empirical studies in the US report a negative relationship between debt and R&D (e.g., Brown et al., 2009; Faulkender et al., 2012; Jung and Song, 2011). Also, Ortiz-Molina and Phillips (2014) report that real asset illiquidity increases the cost of capital. The literature also suggests that firms use capital structure to strategically manage risk (Dierker et al., 2013) or earnings volatility (Dang et al., 2014a), which implies that firms with innovate investments may adopt conservative financing structures to counteract the high risks associated with their investments portfolios. Similarly, a study in the US over the twentieth century by Krainer (2014) reports that managers make investment decisions consistent with the risk aversion of shareholders and use capital structure to offset any changes in operating risk arising from changes in investment decisions. Consistent with the pecking order theory, Himmelberg and Petersen (1994) report that the presence of financial constraints further strengthens the hierarchical preferences of financing sources with internal equity as the most preferred source of financing for firms with highly innovative investments.

innovation. Combined, the existence of specialised lenders and innovation in capital markets allows innovative firms to access debt financing.[4] Further, the scale of innovative investments may necessitate accessing capital markets more frequently as the internal financing may be inadequate (see, Cornaggia et al., 2015; Hall and Lerner, 2010). These mixed predictions on the role of debt in financing innovation and the rather persistent leverage against increasing R&D, and falling collateral values highlight the need for further research.

To put the changes in the composition of corporate investments in the UK into perspective, between 1990 and 2000, R&D investments only accounted for 2%−4% of total assets, with this proportion increasing considerably to a range between 5%−7% from 1998 onwards until the onset of the recent global financial crisis.[5] In contrast, fixed capital expenditure which used to constitute the majority of corporate investments receded from averages just above 8% in the 80s and early 90s, to between 6% and 8% through 2000, and falling further below 6%, thereafter. However, Figure 3.1 in Chapter 3 shows that corporate debt levels have been rising throughout the sample period, with the exception of short-term debt. The debt-to-collateral ratio increases significantly over time, reaching a peak of 85%, 52%, 61%, 26%, and 203% for total debt, net-debt, long-term debt, short-term debt and total liabilities in 2008 (around the crisis period), , respectively. The increase in leverage is consistent with Graham et al. (2015), who report that corporate leverage has more than tripled over the past century in the US.[6] What explains these rather unexpected trends in financing and investment activities remains largely an empirical question, especially the relationship between financing activities and real decisions in the presence of market imperfections is rather ambiguous (Chava and Roberts, 2008; Stein, 2003).[7]

[4] Further, innovation in capital markets (in the form of new financing instruments) and the emergence of specialised lenders allows access to financing that would not ordinarily exist for innovative investments. A model of Michalopoulos et al. (2009) predicts that technological innovation and economic growth will eventually stop unless there is continuous financial innovation.

[5] Ongoing advances in the technological sector indicate that the increase in intangible investments is more of a long-term phenomenon (Michalopoulos et al., 2009).

[6] Further, Figure 3.1 in Chapter 3 shows that the proportion of long-term debt is increasing in the UK.as short-term debt is decreasing over time. This result is in contrast to Custódio et al. (2013) who report marked decreases in debt with maturity greater than three years in the US from 53% in 1976 to 6% in 2008.

[7] Similar to the irrelevancy theorem (Modigliani and Miller, 1958), the "separation principle" posits

This chapter provides empirical evidence on the differences in financing decisions of innovative and non-innovative firms in the UK over the period 1987-2013. To formally examine these differences, the analyses in this chapter adopt a de-compositional approach in dynamic leverage regressions estimated via system Generalised Methods of Moments (system GMM thereon). The adoption of a de-compositional approach allows for an analysis of the components of leverage (total debt, net-debt, long-term debt and total liabilities), while the system GMM estimation technique controls for potential endogeneity and unobserved firm-specific effects.[8] The main prediction is that the coefficients on the determinants of leverage differ across the four components of leverage, and between innovative and non-innovative firms. The second prediction is that the relationship between investment and leverage has changed over time, with innovative firms increasingly being able to access debt financing.[9] In order to investigate the changes in the relationship between leverage and the firm specific characteristics, the analyses in this chapter estimate 5-year rolling regressions over the period 1983 to 2013. In further examinations of the changes in the relationship between leverage and the leverage determinants, the sample is divided into six non-overlapping periods; 1987-1990, 1991-1995, 1996-2000, 2001-2005, 2006-2010, and 2011-2013, upon which comparisons are drawn.

This chapter makes three contributions to the literature. First, the results show that innovative and non-innovative firms have similar financing structures (capital structure and debt maturity) as is consistent with the hypothesis that there is an improvement in access to financing for innovation. The similarities in debt financing remain despite the overall negative effect of R&D on leverage. These similarities in financ-

that the financing and investment decisions are independent (Jackson et al., 2013). This prediction is rather contrary to studies that have converged on the idea that the investment and financing decisions inter-dependent in the presence of market imperfections (e.g., Kim, 1978; Krasker, 1986; Kraus and Litzenberger, 1973; Miller, 1977; Myers, 1984; Scott, 1976).

[8] Sufi (2009) highlights that one major limitation of existing studies in the US on capital structure is their apparent failure to recognise debt heterogeneity. This chapter extents this intuition by linking the compositional changes in leverage to changes in corporate investments. Further, DeAngelo and Roll (2015) and Welch (2004) also highlight that the components of leverage exhibit high variability over time even though on aggregate leverage is relatively stable.

[9] Consistent with this predictions, Chava et al. (2013) report that loan spreads for US firms decrease significantly with patent citations.

ing structure are not consistent with the predictions of the information asymmetry theory, neither with the results of prior studies which suggest that firms with more intangible assets should be financed with equity (e.g., Borisova and Brown, 2013; Brown and Petersen, 2009, 2011; Hall, 2009). Rather, the result is consistent with Chava et al. (2013), who report that lending institutions that specialise in financing innovation recognise their collateral values, and avail credit at relatively favourable rates. Similarly, Stroebel (2015) reports that integrated lenders who supposedly have superior information about the collateral values of the firm's assets charge relatively lower interest rates than non-integrated lenders. The relatively low debt financing for innovative firms from 2001 to 2013 suggests an increase in risk aversion in the post tech-bubble. This result is consistent with studies in the US that report increases in idiosyncratic risk (e.g., Campbell et al., 2001; Kang et al., 2011). The low debt financing for innovative firms from 2001 to 2013 show that managers counteract increases idiosyncratic risk through reducing debt.

Second, the time varying coefficients of R&D, capital expenditure, tangible assets and intangible assets, show that the relationship between leverage and investment, or leverage and corporate assets, is rather dynamic. Consistent with the results presented in this chapter, the relationship between leverage and investment differs across the four measures of leverage (total debt, net-debt, long-term debt and total liabilities) used in this analysis. Furthermore, our results show that the effects of investment on leverage are neither persistently positive nor negative, but change in both sign and significance over time and across the four different measures of leverage. The observed time variation in the relationship between leverage and investment shed light on why prior studies report mixed results.[10]

Third, the negative-effect of R&D on leverage decreases during a time period when innovative firms have roughly the same leverage as non-innovative firms. This de-

[10]The results on the linkages between investment and financing decisions are rather mixed as Caglayan and Rashid (2014) and Lyandres and Zhdanov (2005) report a positive relationship, while Aivazian et al. (2005), DeAngelo and Masulis (1980), Dang (2011) and Lang et al. (1996) report a negative relationship.

crease prior to the period 2005-2010 is consistent with Begenau and Palazzo (2015) who suggest that banks that specialise in financing innovation recognise the value of these investments, and advance credit at comparatively lower rates than other lenders. Of particular interest, is also the positive relationship between leverage and intangible assets, except on total liabilities. This positive relationship suggests that intangible assets facilitate access to debt financing in a similar way as tangible assets. The negative effect of tangible assets and intangible assets on total liabilities is consistent with the prediction that firms with access to capital markets use less short-term debt. Further, the results show that intangible assets and tangible assets have a relatively higher positive effect on leverage for innovative firms than non-innovative firms. This results suggests that collateral (both tangible assets and intangible assets) plays a significant role in facilitating access to debt financing for firms likely to face binding credit constraints. Overall, the effects of investment and tangible/intangible assets on leverage are statistically significant, even after accounting for the dynamic nature of corporate decisions and other standard determinants of capital structure.

The analysis in this chapter relates to studies on the relationship between finance and investment activities.[11] Prior studies largely focus on the relationship between capital expenditure and leverage, while overlooking the large increase in R&D, and the dynamic nature of the relationship between corporate investment and financing activities.[12] Further, prior studies assume that debt is homogeneous, but the results in this chapter show that debt is rather heterogeneous with its components changing over time.[13] Similarly, DeAngelo and Roll (2015) highlight that the stability of leverage or the importance of firm fixed effects is a temporary phenomenon which occurs at low levels of leverage, with most firms abandoning conservative financing

[11]Several studies examine the relationship between finance and investment activities (e.g., Aivazian et al., 2005; Chava and Roberts, 2008; Dammon and Senbet, 1988; Dang, 2011; DeAngelo and Masulis, 1980; Lang et al., 1996; Lyandres and Zhdanov, 2005; Mauer and Triantis, 1994; Stein, 2003).

[12]For prior studies on the relationship between investment and financing decisions, see Aivazian et al. (2005), Dang (2011), DeAngelo and Masulis (1980), Lang et al. (1996), and Lyandres and Zhdanov (2005).

[13]Rauh and Sufi (2010) highlight that debt is rather non-homogeneous, yet, the existing literature assumes that debt is homogeneous.

policies over time.[14] This chapter adds new insights by highlighting that the relationship between leverage and firm specific factors changes over time and across the four components of leverage.

This chapter complements the growing literature on R&D by providing results that shows that changes in corporate investment affect the debt-equity choice.[15] This chapter also relates to recent studies in the US by Dudley (2012), Elsas et al. (2013) and Whited (2006) on the effects of large corporate investments on capital structure. This chapter builds on the results by Dudley (2012), Elsas et al. (2013) and Whited (2006) by showing that in addition to the size of corporate investments, the forms of corporate investments affect capital structure and heterogeneity in preferences when accessing capital markets to financing investments. Further, the results from the analysis in this chapter show that the relationship between leverage and investment is dynamic which helps in explaining the mixed results in the literature.

The rest of this chapter is organised as follows. Section 4.3 presents the methodology used, Section 4.4 discusses the the empirical results, Section 4.5 presents robustness tests, and Section 4.6 concludes.

4.3 Methodology

Dynamic panel data models are used to investigate the determinants of leverage and differences between innovative and non-innovative firms. The first part of the analysis involves estimating a dynamic panel data model on firm specific factors. The second part involves estimating the sensitivity of leverage to investment and corporate assets using a series regressions over the periods 1987-1992, 1993-1998, 1999-2004, 2005-2010 and 2011-2013. The last section of the analysis involves estimating the probability of issuing or retiring debt or equity using logistic regression models.

[14]Several studies report that leverage is rather stable and that fixed effects are important to the understanding of the determinants of capital structure (e.g., Frank and Goyal, 2008; Graham and Leary, 2011; Hanousek and Shamshur, 2011; Lemmon et al., 2008; Parsons and Titman, 2007; Rauh and Sufi, 2012).

[15]For studies on R&D, see Acemoglu et al. (2010), Borisova and Brown (2013), Brown et al. (2009), Brown et al. (2012), Hall (2002), Hall (2009), Hall and Lerner (2010) and Moshirian et al. (2013).

The baseline model in which leverage is specified as a function of lagged leverage and firm specific factors is:

$$L_{it} = \alpha + \gamma L_{it-1} + \boldsymbol{\beta}\mathbf{X}_{it-1} + \zeta_i + \epsilon_{it} \tag{4.1}$$

where L_{it} is the leverage of firm i at time/year t, α is a constant, γ is a coefficient and $\boldsymbol{\beta}$ is vector of coefficients to be estimated, L_{it-1} is lagged leverage, $\mathbf{X}_{it-1}$ is a vector of firm specific factors explained below, ζ_i represents time-invariant unobservable firm-specific effects, and ϵ_{it} is an error term. The vector of firm specific factors, $\mathbf{X}_{it-1}$, includes R&D, capital expenditure (Capex), tangible assets, intangible assets and control variables (growth, size, profit, non-debt tax shield (NDTS) and volatility). The choice of these determinants of capital structure is motivated by the literate.[16] The analysis in this chapter uses a de-compositional approach in which leverage is defined as total debt, net-debt, long-term debt or total liabilities. The application of a de-compositional approach on leverage is in line with Welch (2004) who highlight that although leverage is relatively stable or persistent on aggregate (as Lemmon et al. (2008) and Hanousek and Shamshur (2011) report), non-innovative and innovative firms' components (long-term and short-term debt) vary over time.[17] All variables used are defined in Table 3.2 on page 46 in Chapter 3.

In order to investigate the differences between innovative and non-innovative firms, Equation (4.1) is modified as follows:

$$L_{it} = \alpha + \gamma^{NIN} L^{NIN}_{it-1} + \gamma^{INN} L^{INN}_{it-1} + \boldsymbol{\beta}^{NIN}\mathbf{X}^{NIN}_{it-1} + \boldsymbol{\beta}^{INN}\mathbf{X}^{INN}_{it-1} + \eta_i + \xi_{it} \tag{4.2}$$

where L_{it} is the leverage of firm i at time/year t, α is a constant, γ is a coefficient and $\boldsymbol{\beta}$ is vector of coefficients to be estimated, L_{it-1} is lagged leverage, $\mathbf{X}_{it-1}$ is a vector of firm specific factors explained below, η_i represents time-invariant unobservable

[16] For a review of the reliable determinants of capital structure, see Frank and Goyal (2009), Oztekin (2015) and Parsons and Titman (2007).

[17] DeAngelo and Roll (2015) report similar results which show that the observed stability in leverage is a temporary phenomenon, which only occurs at lower levels of leverage as firms actively adjust capital structure in the long-run.

firm-specific effects, and ξ_{it} is an error term. The focus of the analysis in Equation (4.2) is on whether the coefficients on the determinants of leverage differ between non-innovative (*NIN*) and innovative firms (*INN*). Equation (4.2) is used to analyse the differences in the coefficients on R&D, capital expenditure, tangible assets and intangibles assets between innovative and non-innovative firms. The advantages of using Equation (4.2) over separate estimations of Equation (4.1) for innovative and non-innovative firms is that Equation (4.2) has higher degrees of freedom and allows for direct tests on the differential effects of the firm specific factors on leverage. Results from separate estimations of Equation (4.1) for non-innovative and innovative firms are also presented for robustness.

This chapter also investigates the effects of corporate investments (R&D and Capex) and (intangible and tangible) assets on the probability of issuing equity or debt (repurchasing equity or debt) by estimating the following logistic regression:

$$D^*_{it} = \lambda_0 + \boldsymbol{\lambda}\mathbf{X}_{it-1} + \nu_i + \mu_{it} \tag{4.3}$$

where D^*_{it} is a dummy variable equal to one for firm i at time t if the firm issues equity or debt (repurchases equity or retires debt), and zero otherwise, λ_0 is a constant, $\boldsymbol{\lambda}$ is a vector of parameter coefficients to be estimated, $\mathbf{X}_{it-1}$ is a vector of firm specific factors explained below, μ_i represents time-invariant unobservable firm-specific effects, and ν_{it} is an error term. Consistent with Hovakimian et al. (2001), Hovakimian et al. (2004), Korajczyk and Levy (2003) and Leary and Roberts (2005) equity or debt issues (repurchases) are defined in this chapter as any net change in equity or debt from the previous period scaled by the beginning total assets in excess of 5%. The vector of firm specific factors, $\mathbf{X}_{it-1}$, includes R&D, capital expenditure (Capex), tangible assets, intangible assets and control variables (size, profit, non-debt tax shield (NDTS) and volatility).

The inclusion of the lagged dependant variable in Equations (4.1) and (4.2) renders ordinary least squares (OLS) estimates biased and inconsistent. Equations (4.1) and

(4.2) are estimated using system GMM, which uses all moment conditions as it combines equations estimated in levels with those in differences to increase efficiency.[18] The system GMM estimation techniques allow for the use of first differenced and lagged level variables as instruments to control for potential endogeneity problems (Blundell and Bond, 1998).[19] The Hansen test (*J* test) provides a test for the validity of the instruments used (at 5% level), and is asymptotically distributed as chi−square with degrees of freedom equal to the difference between the number of instruments and parameters. The Arellano and Bond (1991) test for second order serial correlation in the differenced residuals (*m2*) is used to test for auto-correlation and provides a further test on the correct specification of the empirical model. *m2* is asymptotically normal under the null of no second−order serial correlation of differenced residuals. The *m2* and *J statistic* are presented for all results estimated using system GMM.

4.4 Empirical results

The empirical results in this section are organised as follows: Section 4.4.1 analyses the effects of R&D and capital expenditure (Capex) on leverage (total debt, net-debt, long-term debt and total liabilities); Section 4.4.2 presents results on the differential effects of R&D, capital expenditure (Capex), tangible assets, and intangible assets on leverage between innovative (INN) and non-innovative firms (NIN); Section 4.4.3 presents results on the time varying effects of R&D, capital expenditure (Capex), tangible assets and intangible assets on leverage, and Section 4.4.6 presents results on the effects of R&D and capital expenditure (Capex) on the probability of issuing (retiring or repurchasing) equity and debt.

[18] Estimates using OLS FE (fixed effects) and pooled OLS that excludes the lagged dependent variables are also presented in Appendix 4.C for robustness and to facilitate comparisons with prior studies.

[19] The instruments used are restricted to the second and fifth lags to address the problem of having excessive instruments which proliferates as the sample size increases (Mehrhoff, 2009; Roodman, 2009; Vincent and Michaely, 2012).

Table 4.1 Determinants of financing structure

The table presents the results of estimating Equation (4.1) that relates leverage to lagged leverage, research and development (R&D), capital expenditure (Capex), tangible assets, intangible assets, growth, size, profit, non-debt tax shield, and earnings volatility. TDA is total debt to total assets, NDA is net-debt to total assets, LTDA is long-term debt to total assets and TLTA is total liabilities to total assets. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. The results are estimated via system GMM. The table reports the *J statistic* from a test of the over identifying restrictions, and the *J statistic* is asymptotically distributed as chi-squared under the null of instrument validity, and the test of second-order autocorrelation (*m2*) in the first differenced residuals. Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Variables	TDA	NDA	LTDA	TLTA
Lev_{it-1}	0.758***	0.683***	0.711***	0.755***
	(0.032)	(0.035)	(0.031)	(0.044)
R&D	-0.147***	-0.194***	-0.058**	-0.314***
	(0.034)	(0.065)	(0.023)	(0.048)
Capex	0.116***	0.161***	0.060*	0.035
	(0.036)	(0.045)	(0.031)	(0.034)
Tangible	0.058***	0.214***	0.066***	-0.021
	(0.012)	(0.024)	(0.010)	(0.015)
Intangible	0.046***	0.208***	0.068***	-0.028**
	(0.012)	(0.023)	(0.011)	(0.014)
Growth	0.000	-0.004*	0.000	0.005*
	(0.001)	(0.002)	(0.001)	(0.003)
Size	0.005***	0.002**	0.005***	0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
Profit	-0.180***	-0.219***	-0.069***	-0.297***
	(0.015)	(0.022)	(0.010)	(0.021)
NDTS	-0.281***	-0.382***	-0.175***	0.220**
	(0.061)	(0.086)	(0.053)	(0.092)
Volatility	-0.114***	-0.221***	-0.038*	-0.128***
	(0.027)	(0.036)	(0.020)	(0.038)
Constant	-0.009	-0.054**	-0.049***	0.037*
	(0.013)	(0.021)	(0.011)	(0.019)
N	7579	7579	7579	7579
m2	1.084	-0.592	1.007	0.222
p-value	(0.278)	(0.554)	(0.314)	(0.824)
J	66.227	68.627	67.640	69.781
p-value	(0.606)	(0.524)	(0.558)	(0.485)

4.4.1 Determinants of financing structure

Table 4.1 presents the results of Equation 4.1 which relates leverage (total debt, net-debt, long-term debt and total liabilities) to R&D, capital expenditure (Capex), tangible assets, intangible assets and other firm specific factors. Each column present results with the dependent variable being total debt (TDA), net-debt (NDA), long-term debt (LTDA) and total liabilities (TLTA), respectively.

The *m2* and *J statistic* in Table 4.1 show that there are no concerns with second-order auto-correlation and the validity of the instruments. The coefficients on lagged leverage are consistently positive and significant across the four measures of leverage (total debt, net-debt, long-term debt and total liabilities). This result suggests that leverage is persistent, and firms that have debt financing are more likely to continue using debt financing in the future. Denis (2012), Hanousek and Shamshur (2011), Lemmon et al. (2008) and Wu et al. (2012) also report high persistence in leverage. In particular, Lemmon et al. (2008) highlight that firms in the US with high (low) leverage remain relatively highly (lowly) leveraged over time. The persistence in leverage is attributed to firm specific effects which, according to Lemmon et al. (2008), explain much of the observed variation in capital structure. Similarly, Hanousek and Shamshur (2011) report high persistence in leverage for firms in economies in transition (Czech Republic, Hungary, Estonia, Poland, Latvia, Lithuania and Slovakia). Net-debt has relatively low persistence than other measures of leverage (total debt, long-term debt and total liabilities). Acharya et al. (2007), Acharya et al. (2012), Ang and Smedema (2011) and Bates et al. (2009) report that firms increase cash holdings to preserve corporate flexibility, which would explain the relatively lower persistence in net-debt.

The coefficients on R&D in Table 4.1 are consistently negative and significant. The negative effect of R&D on leverage is relatively high on total liabilities, while it is relatively low on long-term debt. This significant inverse relation between R&D and leverage is in line with theoretical predictions that firms that are more prone to information asymmetry, asset substitution, and poor collateral problems use less debt financing (Brown et al., 2012; Borisova and Brown, 2013; Hall, 2009; Hall et al., 2009). Similarly, Aghion et al. (2004) report that firms with huge investments in innovative projects adopt more conservative financing structures in order to maintain strategic flexibility which is likely to be constrained by restrictive debt covenants. According to O'Brien (2003), strategic flexibility is more important to the survival of firms in competitive innovative products market. The negative effect of R&D on leverage obtains despite the similar trends in financing shown in Figure 3.1 (page 63) of Chapter 3.

The positive coefficients on capital expenditure shows that leverage increases with capital expenditure (Capex). This coefficient is significant on total debt and net-debt, while it is marginally significant on long-term debt and rather insignificant on total liabilities. This significant positive effect of capital expenditure on total debt is in line with the literature (Lyandres and Zhdanov, 2005; Caglayan and Rashid, 2014) and suggests that further investments in physical assets support debt financing (Almeida and Campello, 2007; Campello and Giambona, 2013). However, Aivazian et al. (2005), Dang (2011), DeAngelo and Masulis (1980) and Lang et al. (1996) report a negative relation between capital expenditure and leverage.[20] The increase in leverage with capital expenditure is also consistent with Almeida and Campello (2007) who report that pledgeable assets support debt financing. Overall, these findings suggest that investment variables have a significant effect on leverage with the effect depending on the type of investment.

It is interesting to note that tangible assets and intangible assets have similar significant positive effects on leverage, except for total liabilities where the effect is negative and only significant on intangible assets. The similar effects of intangible assets and tangible assets are inconsistent with theoretical predictions that intangible assets subject firms to binding credit constraints (Brown et al., 2012). The results in Table 4.1 shows that intangible assets support debt financing.[21] The negative effect of intangible assets on total liabilities suggests that firms tend to prefer long-term debt and avoid short-term debt as it increases refinancing risks.

The results on the control variables (size, profit, non-debt tax shield and volatility) are consistent across the different measures of leverage (total debt, net-debt, long-term debt and total liabilities), with prior studies, and of the sign predicted by theory,

[20] The significant positive relation between capital expenditure and leverage is in line studies on corporate investments dynamics that tests the over-investment proposition (Jensen, 1986; Lyandres and Zhdanov, 2005). The positive relationship reported in the literature is consistent with the over-investment proposition which predicts that firms with debt overhang may invest in further risky projects as the profits or losses arising from these projects accrue asymmetrically. Equity holders benefit more from profitable projects as interest on debt is fixed while due to limited liability, equity holders do not similarly share the burden of losses arising from unprofitable projects (Jensen, 1986; Lyandres and Zhdanov, 2005). On the other hand, debt overhang concerns may lead to under-investment as the profits from investments undertaken will largely accrue to debt-holders who have a first claim to the assets of a firm in case of bankruptcy.

[21] Lim et al. (2014) report that intangible assets reported in the purchase price allocation data of the bidding firms' 10-Ks or 10-Qs in the US play a similar role as tangible assets in facilitating access to debt financing. The analysis in this chapter extents on these results by showing that both acquired and internally generated intangible assets support debt financing.

except for growth and non-debt tax shield. Size has a consistent significant and positive effect on leverage, while profit and volatility have a significant negative effect on leverage. The positive effect of size on leverage is consistent with the proposition that the risk of bankruptcy is low for large firms (e.g., Elsas et al., 2013; Faulkender et al., 2008, 2012; Frank and Goyal, 2009; Leary and Roberts, 2005). Large firms have more assets with which to pledge as collateral to support borrowings. Lenders are also more willing to advance credit to larger firms as information asymmetry problems decrease with size (Drobetz and Wanzenried, 2006; Vincent and Michaely, 2012). Further, the need to maintain a good credit history increases with size (reputational concerns) which reduces the probability of default (Strebulaev and Kurshev, 2006).

The negative effect of profitability on leverage is consistent with the predictions of the pecking order theory that retained earnings are preferred to external sources of financing (Myers, 1984; Myers and Majluf, 1984). The negative effect of earnings volatility is consistent with Antoniou et al. (2008), Dang et al. (2012), and Dang et al. (2014a). According to Fama and French (2002), firms with high earnings volatility have higher financial distress costs, hence, should use less debt financing. Similarly, Krainer (2014) reports that managers choose investments that are consistent with the risk aversion of shareholders and use capital structure to offset deviations from the acceptable operating risk thresholds. The effects of growth and non-debt tax shield on leverage are rather mixed. Growth has a marginally significant effect on net-debt and marginally positive effect on total liabilities, while it has an insignificant positive effect on total debt and long-term debt. The mixed and insignificant results on growth are inconsistent with Frank and Goyal (2009) and Oztekin (2015) who report significant effects of growth on leverage in the US and several countries, respectively.

Non-debt tax shield has a significant negative effect on total debt, net-debt and long-term debt, while it has a positive effect on total liabilities. The negative effect of non-debt tax shield on leverage is consistent with the proposition that firms substitute debt tax shield for non-debt tax shield (Dang et al., 2012, 2014a; DeAngelo and Masulis, 1980; de Miguel and Pindado, 2001; Leary and Roberts, 2005). The positive effect of non-debt tax shield is inconsistent with the substitution hypothesis between non-debt tax shield and debt tax shield, but consistent with Antoniou et al. (2008), Frank and Goyal (2009) and Titman and Wessels (1988). According to Antoniou et al. (2008), Frank and Goyal (2009) and Titman and Wessels (1988) the positive effect of growth on leverage suggests that high-growth-firms tend to use more debt financing, whereas theory posits that the use of leverage may subject high-growth-firms to underinvestment problems arising from debt overhang concerns (Myers, 1977).

Overall, using a dynamic model of leverage, the results show that the coefficients associated with tangible assets, intangible assets, growth and non-debt tax shield differ across models. This observed variation provide evidence that leverage is not homogeneous.[22] The following section draws comparisons between innovative and non-innovative firms from models estimated on total debt, net-debt, long-term debt and total liabilities. The focus of the following section is on whether R&D, capital expenditure, tangible assets and intangibles assets have differential effects on leverage between innovative and non-innovative firms.

4.4.2 Determinants of financing structure: Innovative and non-innovative firms

Table 4.2 presents the results of Equation 4.2 which relates leverage to R&D, capital expenditure and other firm specific factors for innovative and non-innovative firms. Also presented in Table 4.2 are the p-values for the t-tests of the differences in the coefficients between innovative and non-innovative firms.

Table 4.2 shows relatively high persistence in leverage for non-innovative firms, except for total liabilities. The significant difference in the persistence of leverage (TDA,

[22]According to Rauh and Sufi (2010), a major limitation of empirical studies on capital structure is their failure to recognise the heterogeneity in debt financing due to data limitations or the desire to maintain tractability.

Table 4.2 Determinants of financing structure: Innovative versus non-innovative firms

The table presents the results of estimating Equation (4.2) that relates leverage to lagged leverage, research and development (R&D), capital expenditure (Capex), tangible assets, intangible assets, growth, size, profit, non-debt tax shield, and earnings volatility. TDA is total debt to total assets, NDA is net-debt to total assets, LTDA is long-term debt to total assets and TLTA is total liabilities to total assets. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. The results are estimated via system GMM. The table reports the *J statistic* from a test of the over identifying restrictions, and the *J statistic* is asymptotically distributed as chi-squared under the null of instrument validity, and the test of second-order autocorrelation (*m2*) in the first differenced residuals. Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	TDA			NDA			LTDA			TLTA		
Variables	NIN	INN	Diff (p-value)	NIN	INN	Diff (p-value)	NIN	INN	Diff (p-value)	NIN	INN	Diff (p-value)
Lev_{it-1}	0.838***	0.684***	(0.005)	0.799***	0.588***	(0.002)	0.788***	0.615***	(0.004)	0.722***	0.767***	(0.570)
	(0.045)	(0.041)		(0.057)	(0.041)		(0.044)	(0.040)		(0.066)	(0.051)	
R&D		-0.166***	(0.000)		-0.209***	(0.001)		-0.060**	(0.012)		-0.276***	(0.000)
		(0.039)			-0.065			-0.024			-0.053	
Capex	0.164***	0.044	(0.065)	0.231***	0.055	(0.039)	0.108*	0.024	(0.188)	0.107**	-0.072	(0.006)
	(0.053)	(0.039)		(0.063)	(0.059)		(0.058)	(0.032)		(0.047)	(0.048)	
Tangible	0.037**	0.093***	(0.015)	0.126***	0.336***	(0.000)	0.051***	0.087***	(0.070)	-0.033*	-0.005	(0.317)
	(0.015)	(0.017)		(0.024)	(0.040)		(0.014)	(0.015)		(0.020)	(0.022)	
Intangible	0.023	0.077***	(0.009)	0.128***	0.313***	(0.000)	0.047***	0.089***	(0.036)	-0.023	-0.022	(0.984)
	(0.017)	(0.016)		(0.027)	(0.033)		(0.015)	(0.015)		(0.019)	(0.019)	
Growth	-0.001	0.001	(0.549)	-0.005*	-0.002	(0.471)	0.000	0.000	(0.938)	0.012**	0.002	(0.105)
	(0.002)	(0.001)		(0.003)	(0.002)		(0.002)	(0.001)		(0.006)	(0.003)	
Size	0.004***	0.004***	(0.465)	0.004***	-0.001	(0.000)	0.005***	0.005***	(0.975)	0.008***	0.007***	(0.687)
	(0.001)	(0.001)		(0.002)	(0.001)		(0.001)	(0.001)		(0.003)	(0.002)	
Profit	-0.197***	-0.168***	(0.376)	-0.258***	-0.184***	(0.037)	-0.078***	-0.058***	(0.332)	-0.315***	-0.269***	(0.219)
	(0.020)	(0.022)		(0.028)	(0.023)		(0.018)	(0.011)		(0.026)	(0.029)	
NDTS	-0.308***	-0.222***	(0.437)	-0.319***	-0.375***	(0.713)	-0.231**	-0.133**	(0.365)	0.110	0.362***	(0.216)
	(0.083)	(0.073)		(0.116)	(0.105)		(0.091)	(0.063)		(0.159)	(0.122)	
Volatility	-0.103***	-0.090**	(0.799)	-0.199***	-0.241***	(0.589)	-0.050	-0.009	(0.299)	-0.055	-0.217***	(0.025)
	(0.039)	(0.040)		(0.072)	(0.031)		(0.033)	(0.024)		(0.057)	(0.042)	
Constant	-0.018			-0.063**			-0.054***			0.049**		
	(0.015)			(0.027)			(0.013)			(0.019)		
N	7579			7579			7579			7579		
m2	1.005			-0.657			1.160			0.242		
p-value	(0.315)			(0.511)			(0.246)			(0.809)		
J	137.778			143.968			152.702			144.077		
p-value	(0.537)			(0.392)			(0.219)			(0.389)		

NDA and LTDA) between innovative and non-innovative firms suggests that past financing decisions are more important for non-innovative firms.[23] The high persistence in leverage for non-innovative firms is consistent with the proposition that physical capital investments support debt financing (Almeida and Campello, 2007; Campello and Giambona, 2013; Ortiz-Molina and Phillips, 2014). The insignificant differences between innovative and non-innovative firms in the coefficient on lagged total liabilities is consistent with the results in Table 3.3 and suggest that the two firm-groups adopt similar financing structures (when considering total liabilities).

R&D has a significant and negative effect on total debt, net-debt, long-term debt and total liabilities. The negative effects of R&D on leverage is consistent with the existing literature (e.g., Aghion et al., 2004; Dang et al., 2014a; Elsas and Florysiak, 2013; Hall, 2002) which highlights that firms with innovative investments use less debt financing. This is consistent with studies which report that the special features (high information asymmetry, asset substitution problems, and poor collateral values) of innovative investments are likely to subject firms to binding financial constraints (Borisova and Brown, 2013; Brown and Petersen, 2009, 2011; Brown et al., 2012; Moshirian et al., 2013). The negative effect of R&D on leverage which suggests that innovative firms should adopt conservative financing structures is inconsistent with the relatively high leverage of innovative firms as shown in Figure 3.1 (page 63) in Chapter 3.

The effect of capital expenditure on leverage varies across the different measures of leverage and between innovative and non-innovative firms. Consistent with Lyandres and Zhdanov (2005), capital expenditure has a positive effect on leverage except

[23] Denis (2012), Hanousek and Shamshur (2011), Lemmon et al. (2008) and Wu et al. (2012) have re-ignited the debate on the persistence in leverage. The results reported by Lemmon et al. (2008) pervades the literature and suggests that much of the insights in the literature on the importance of other factors in in explaining the variation corporate capital structure are rather misleading (as the factors identified in the literature only explain a small proportion (6%) of the variations in capital structure). Following Lemmon et al. (2008), Frank and Goyal (2009), Graham and Leary (2011), Parsons and Titman (2007) and Sufi (2009) which have all emphasised the importance of firm fixed effects in explaining the variations in corporate capital structure. However, DeAngelo and Roll (2015) report that leverage vary greatly and is only stable at lower levels with the stability being a temporary phenomenon.

for non-innovative firms in the case of total liabilities where the effect is negative but insignificant. The effect of capital expenditure on leverage is consistently insignificant for innovative firms, while it is significant for non-innovative firms. The differences on the effects of capital expenditure on leverage are significant on net-debt and total liabilities, and only marginally significant on total debt and rather insignificant on long-term debt. The mixed results in the literature may be explained in part by the different definitions of leverage used in previous studies or the failure to take into account the heterogeneity in the effects of firm specific factors across different firm groups.[24]

The coefficients on tangible and intangible assets differ between innovative and non-innovative firms. However, this difference is insignificant on total liabilities due to the inclusion of non-financial factors in total liabilities. Rajan and Zingales (1995) highlight that using total liabilities is misleading as the non-financing factors included in total liabilities are mostly for transactional purposes and do not show whether the firm is at risk of default. Consistent with theoretical predictions that collateral reduce information asymmetry problems (Holmstrom and Tirole, 1997; Leland and Pyle, 1977; Leland, 1998), tangible assets have a significant positive effect on leverage (total debt, net-debt and long-term debt), with this effect being significantly higher for innovative firms with less pledgeable assets. Consistent with the results in Table 4.1, intangible assets facilitate access to debt financing for both innovative and non-innovative firms. The positive effect of intangible assets on leverage is consistently higher for innovative firm as they have a larger proportion of non-physical assets as shown in Table 3.3 in Chapter 3. Further, the proportion of intangible assets is increasing rapidly over time (Figure 3.2 in Chapter 3) which shows the transition of economies towards service and technological sectors. This result highlights that the largely overlooked intangible assets in the literature is an important

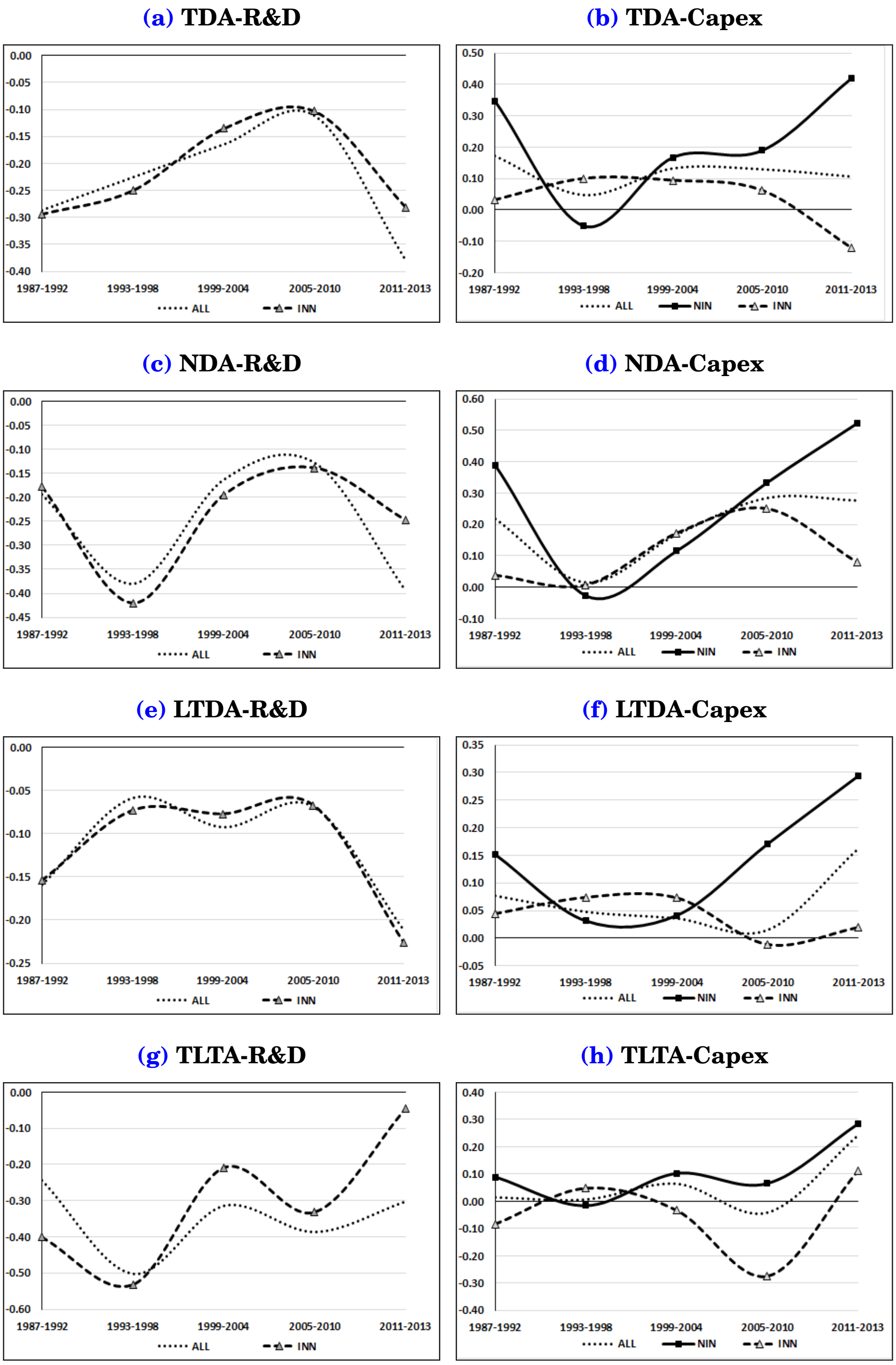
[24] Similarly, Barclay et al. (2006) highlight that there is no particular economic reason to expect the same results from studies that use different definitions of leverage (market leverage and book leverage). The literature is divided with regards to the correct measure of leverage with one group favouring market based measures (Dang et al., 2012; Frank and Goyal, 2007a; Welch, 2004), while the other prefer book based measures (Barclay et al., 2006; Fama and French, 2002; Graham and Harvey, 2001).

determinant of leverage.

Comparisons of the differences in the coefficients on control variables between innovative and non-innovative firms show wide variations across the four measures of leverage. There are significant differences on the effects of size and profit on net-debt between innovative and non-innovative firms. Non-innovative firms increase leverage (net-debt) with size, but this relationship is negative and insignificant for innovative firms. Table 4.2 consistently show a significant and negative effect of profitability on leverage, with this effect being significantly different between innovative and non-innovative firms for net-debt. However, the differences in the coefficients on size and profit are not significant for the other measures of leverage. The insignificant differences of the coefficients on size between non-innovative and innovative firms suggests that size plays a similar role in facilitating access to debt financing, which is consistent with the literature (e.g., Frank and Goyal, 2009; Leary and Roberts, 2005; Oztekin, 2015). The effects of growth, non-debt tax shield and earnings volatility on leverage are not significantly different between innovative and non-innovative firms. The differences in the coefficients of growth are rather insignificant although Table 3.3 reports significant differences in growth rates between innovative and non-innovative firms. Although volatility has a consistently negative effect on leverage, this effect is significant on total debt and net-debt and on total liabilities for innovative firms, but insignificant on long-term debt. The negative effects of earnings volatility on leverage in Table 4.2 is consistent with the theory that predicts that firms use leverage to counteract increases in operating risk (Krainer, 2014). Overall, the comparisons of the differences on the effects of the control variables on leverage suggest that much of the variations in leverage between innovative and non-innovative arises from differences in liquidity management policies, with innovative firms hoarding relatively more cash in order to increase financing flexibility.

The following sub-section investigates time variations of the effects of corporate investment (R&D and capital expenditure) and corporate assets (tangible and intangible assets) on leverage.

Figure 4.1 Time variations of the coefficients on corporate investments



4.4.3 Time variations: Leverage, investment and corporate assets

This section builds on the results in Tables 4.1 and 4.2 by investigating the time variations of the sensitivity of leverage to corporate investments (capital expenditure and R&D) (Figure 4.1) and the sensitivity of leverage to corporate assets (tangible assets and intangible assets) (Figure 4.2). The period 1987-2013 is marked by several episodes of growth dynamics in corporate investments and assets. Figure 3.2 in Chapter 3 shows that the composition of corporate investments is changing, with R&D increasing considerably over time while capital expenditure is decreasing. It also shows that the proportion of collateral supporting debt financing is falling resulting in an increases in debt-to-collateral ratios. Figure 4.1 plots the time series values of the coefficients on R&D and capital expenditure over the period 1983-2013. The time series plots are estimates of Equation (4.2) over five sub periods, which are 1987-1992, 1993-1998, 1999-2004, 2005-2010 and 2011-2013.

The results in Figure 4.1a, 4.1c, 4.1e and 4.1g consistently show that R&D has a negative effect on leverage. The results also show that a significant decrease in the negative effect of R&D on leverage (total debt, net-debt and long-term debt) up to the period 2005-2010, after which it increases significantly. This decrease of the coefficients on R&D suggests that innovative firms increased the use of debt financing and is consistent with the trends on leverage in Figure 3.1 (page 63) of Chapter 3 showing that innovative firms have similar capital structure as no-innovative firms. The result also consistent with Chava et al. (2013) who report that lenders that specialise in financing innovation in the US advance more loans and favourable rates than non-specialist lenders. The increase in the coefficients on R&D after the period 2005-2010 highlight the increase in risk aversion post the global financial crisis. These results show the importance of examining the dynamic nature of the relationship between leverage and R&D as the economy is increasing shift towards service and technology sectors.

Figures 4.1b, 4.1d, 4.1f and 4.1h show similar and significant time variation of the coefficients on capital expenditure. The coefficients on capital expenditure for all firms are mostly positive, except total liabilities in Figure 4.1h, where the coefficient is negative for the period 2005-2010. Further, the results show an increasing positive effect of capital expenditure on total debt (Figure 4.1b) and net-debt (Figure 4.1d) after the period 1993-1998. This marked increase in the coefficients on capital expenditure occurs much later for long-term debt in Figure 4.1f and total liabilities Figure 4.1h. These changes in the coefficients suggest that an increasing proportion of the physical capital expenditure is financed using debt. Comparisons between non-innovative and innovative firms in Figures 4.1b, 4.1d, 4.1f and 4.1h show that the coefficients on capital expenditure are significantly higher for non-innovative firms that face less binding financial constraints. The results also show a decline in the positive effect of capital expenditure on leverage for innovative firms, which turns to a negative effect for total debt, long-term debt and total liabilities. This negative relationship between leverage and capital expenditure for innovative firms suggest that overhang concerns are more significant for firms that invest in innovation. The changes in the sign of the coefficient on capital expenditure highlight that the mixed results in the literature may be due to overlooked time and cross-sectional variations.[25] These differences in the coefficients on capital expenditure between innovative and non-innovative firms are consistent with results in Table 4.2, and further show significant time variations and heterogeneity across the two firm groups.

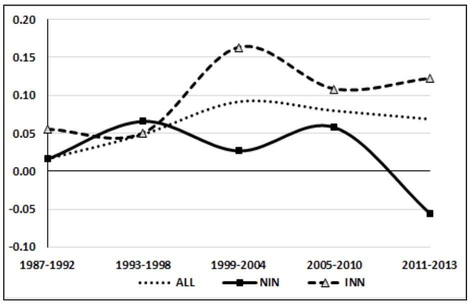
Figure 4.1 shows that the sensitivity of leverage to investment varies over time and across the four measures of leverage, and between innovative and non-innovative firms. The variations in the coefficients on investment variables (R&D and capital expenditure) may help explain the mixed results reported in prior studies.[26] The results in Figure 4.1 also show that time variations and the choice of sample period are likely sources of the mixed results in the literature. The observed time variations in the coefficients highlight the need to examine how changes in the type of firms over time (in addition to within firm changes) affect corporate decisions so as to gain a better understanding of the evolution of the relationship between financing and investment decisions.

[25] One group of studies reports a positive effect of capital expenditure on leverage (e.g., Caglayan and Rashid, 2014; Lyandres and Zhdanov, 2005), while another reports a negative effect (e.g., Aivazian et al., 2005; Dang, 2011; DeAngelo and Masulis, 1980; Lang et al., 1996).

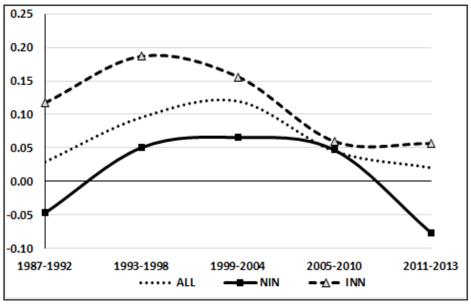
[26] Several studies report mixed or insignificant linkages between investment an financing activities (see, Aivazian et al., 2005; Caglayan and Rashid, 2014; Dang, 2011; DeAngelo and Masulis, 1980; Lang et al., 1996; Lyandres and Zhdanov, 2005; Mauer and Triantis, 1994). Further, Chava and Roberts (2008) and Stein (2003) highlight that the relationship between financing and investment decisions is rather ambiguous.

Figure 4.2 Time series plots of the coefficients on corporate assets

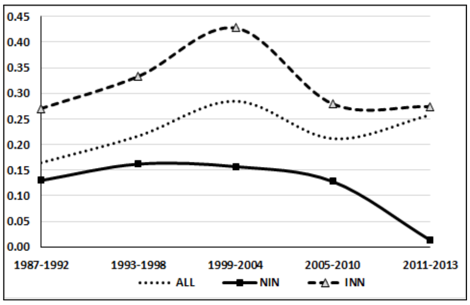
(a) TDA-Tangible assets



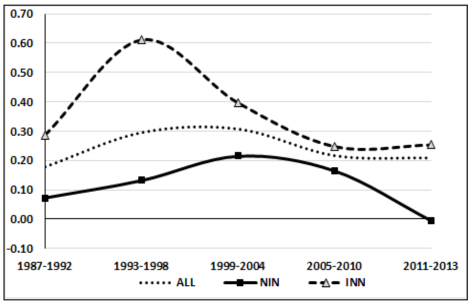
(b) TDA-Intangible assets



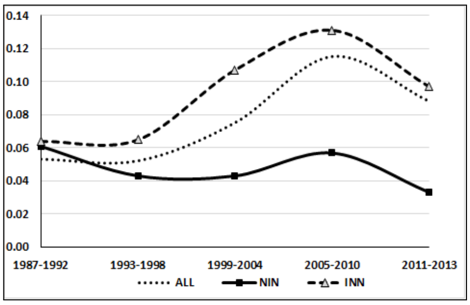
(c) NDA-Tangible assets



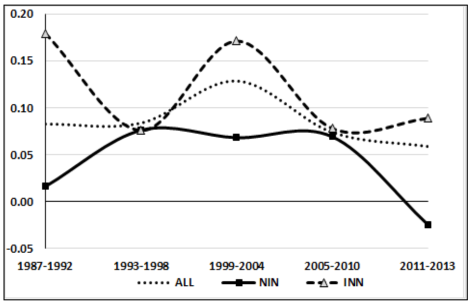
(d) NDA-Intangible assets



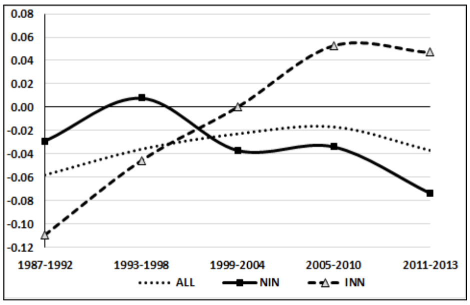
(e) LTDA-Tangible assets



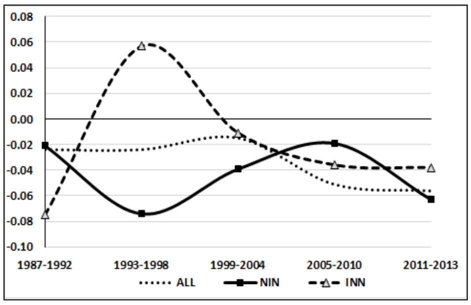
(f) LTDA-Intangible assets



(g) TLTA-Tangible assets



(h) TLTA-Intangible assets



4.4.4 Time variations: Leverage and corporate assets

Figure 4.2 plots time series estimates of the coefficients on tangible and intangible assets over the periods 1987-1992, 1993-1998, 1999-2004, 2005-2010 and 2011-2013. The figure shows that for three proxies of leverage (total debt, net-debt and long-term debt), tangible and intangible assets have similar positive effects on leverage, except when leverage is measured by total liabilities, which are mostly negative. The negative effect of tangible and intangible assets on total liabilities suggests firms with high collateral values (both tangible and intangible assets) rely less on non-financing forms of short-term liabilities (such as trade credit) that are included in total liabilities. The positive coefficients on intangible assets are consistent with those reported in Tables 4.1 and 4.2, and suggest that intangible assets support debt financing. This positive effect of intangible assets on total debt, net-debt and long-term debt is significant even though a small proportion of intangible assets are reported on corporate balance sheets (most intangible assets are off-balance sheet, with accounting standards permitting limited recognition in restricted circumstances (ISA 38)). The positive relationship between leverage and intangible assets is inconsistent with theoretical predictions that firms with high information asymmetry tend to adopt conservative financing structures.[27]

Comparisons of the coefficients on tangible assets and intangible assets between innovative and non-innovative firms show significant differences as is consistent with results in Tables 4.1 and 4.2. Both intangible assets and intangible assets have a significant positive effect on leverage (total debt, net-debt and long-term debt). This shows that collateral plays a significant role in reducing information asymmetry risks by enabling access to debt financing. The time series plots also show that the positive effect of tangible assets on leverage has increased over time, which suggests an increasing role of collateral in reducing information asymmetry as economies transit towards service and technology sectors. The results also further show that tangible assets and intangible assets play significantly higher roles in reducing information asymmetry risks for innovative firms than for non-innovative firms over time. Further, there is a decrease in the coefficients on tangible assets for non-innovative firms, but a significant increase for innovative firms. Similar changes are also observable on intangibles assets, with increases in the positive effect on leverage up to the period 2005-2010, then significant decreases thereafter. This decrease in effect of intangible assets on leverage show an increase in risk aversion post the global financial crisis.

[27] See studies by Borisova and Brown (2013), Brown and Petersen (2009), Brown and Petersen (2011), and Brown et al. (2012).

Overall, the changes in the coefficients show significant time varying effects of intangible and tangible assets on leverage and that the role of collateral in alleviating information asymmetry problems is significantly higher for innovative firms than for non-innovative firms.

The following sub-section investigates the determinants of corporate debt maturity and the differences in debt maturity between innovative and non-innovative firms.

4.4.5 Determinants of debt maturity

Table 4.3 presents the results of estimating Equations (4.1) and (4.2) that relate debt maturity to lagged debt maturity, research and development (R&D), capital expenditure (Capex), tangible assets, intangible assets, growth, size, profit, non-debt tax shield, and earnings volatility. The values in parentheses are the associated standard errors. All models include firm fixed effects and time dummies (not reported) to control for firm-specific and time factors other than those included in the models that might affect debt maturity.

Table 4.3 shows that the coefficients on most firm specific factors are largely consistent with expectations. R&D, size, tangible and intangible assets have a significant and consistent positive effect on debt maturity, while non-debt tax shield and volatility have an insignificant negative effect on debt maturity. The positive significant coefficient on R&D is inconsistent with Custódio et al. (2013), who highlight that it may be optimal for US firms to shorten debt maturity so as to take advantage of refinancing opportunities arising in good macroeconomic states or when the credit rating of the firm has improved. This result is consistent, however, with the model of Diamond and He (2014) which posits that the maturity risk arising from short-term debt has a stronger debt overhang effect on corporate investment than that arising from long-term debt, with this effect being more pronounced for firms subject to high information asymmetry. The increase in debt maturity with size is consistent with the proposition that larger firms have low information asymmetry and results from

Table 4.3 Determinants of debt maturity: Innovative versus non-innovative firms

The table presents the results of estimating Equations (4.1) and (4.2) that relate debt maturity to lagged debt maturity, research and development (R&D), capital expenditure (Capex), tangible assets, intangible assets, growth, size, profit, non-debt tax shield, and earnings volatility. LD1TD is long-term debt maturing in more than one year to total debt, LD3TD is long-term debt maturing in more than three years to total debt, and LD5TD is long-term debt maturing in more than five years to total debt. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. The results are estimated via system GMM. The table reports the *J statistic* from a test of the over identifying restrictions, and the *J statistic* is asymptotically distributed as chi-squared under the null of instrument validity, and the test of second-order auto-correlation (*m2*) in the first differenced residuals. Standard errors (in parenthesis) are robust to auto-correlation and heteroskedasticity. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	LD1TD				LD3TD				LD5TD			
Variables	ALL	NIN	INN	Diff (p-value)	ALL	NIN	INN	Diff (p-value)	ALL	NIN	INN	Diff (p-value)
Lev_{it-1}	0.561***	0.601***	0.434***	(0.348)	0.617***	0.417***	0.579***	(0.230)	0.687***	0.543***	0.724***	(0.103)
	(0.094)	(0.129)	(0.121)		(0.103)	(0.100)	(0.099)		(0.089)	(0.077)	(0.097)	
R&D	0.364***		0.328***	(0.001)	0.193**		0.237**	(0.018)	-0.041		0.042	(0.769)
	(0.107)		(0.099)		(0.091)		(0.100)		(0.143)		(0.143)	
Capex	-0.033	-0.091	-0.015	(0.674)	0.005	0.050	0.044	(0.978)	-0.068	-0.106	-0.009	(0.643)
	(0.092)	(0.133)	(0.123)		(0.105)	(0.146)	(0.139)		(0.125)	(0.157)	(0.144)	
Tangible	0.206***	0.182***	0.291***	(0.179)	0.176***	0.199***	0.213***	(0.830)	0.120***	0.154***	0.153***	(0.991)
	(0.045)	(0.056)	(0.066)		(0.040)	(0.059)	(0.048)		(0.039)	(0.059)	(0.050)	
Intangible	0.180***	0.106**	0.284***	(0.024)	0.175***	0.131**	0.227***	(0.143)	0.122***	0.093*	0.139***	(0.446)
	(0.040)	(0.053)	(0.061)		(0.038)	(0.059)	(0.048)		(0.045)	(0.054)	(0.051)	
Growth	-0.003	-0.005	0.001	(0.591)	-0.010	0.004	-0.016**	(0.242)	-0.002	0.008	0.000	(0.628)
	(0.007)	(0.006)	(0.008)		(0.007)	(0.016)	(0.007)		(0.007)	(0.014)	(0.007)	
Size	0.013***	0.015**	0.017***	(0.726)	0.010***	0.022***	0.012***	(0.090)	0.010**	0.018***	0.009*	(0.068)
	(0.004)	(0.006)	(0.004)		(0.004)	(0.006)	(0.004)		(0.004)	(0.005)	(0.005)	
Profit	0.078**	0.121**	0.022	(0.135)	0.045	0.056	0.065	(0.918)	0.009	0.107	-0.002	(0.303)
	(0.035)	(0.052)	(0.041)		(0.045)	(0.072)	(0.058)		(0.053)	(0.081)	(0.064)	
NDTS	-0.229	-0.063	-0.148	(0.794)	0.103	-0.136	0.318	(0.320)	0.379	0.191	0.277	(0.883)
	(0.169)	(0.258)	(0.213)		(0.216)	(0.342)	(0.326)		(0.316)	(0.326)	(0.545)	
Volatility	-0.047	-0.050	-0.041	(0.943)	-0.114	-0.019	-0.150	(0.494)	-0.196*	0.029	-0.180	(0.306)
	(0.063)	(0.102)	(0.074)		(0.095)	(0.123)	(0.155)		(0.116)	(0.124)	(0.175)	
Constant	-0.009	-0.046			0.078*	0.028			0.119	0.040		
	(0.040)	(0.046)			(0.043)	(0.056)			(0.106)	(0.092)		
N	7579	7579			5686	5686			4617	4617		
m2	1.226	1.025			-0.454	-1.120			0.187	-0.078		
p-value	(0.220)	(0.305)			(0.852)	(0.263)			(0.852)	(0.938)		
J	62.050	127.165			80.889	143.375			81.553	138.716		
p-value	(0.546)	(0.504)			(0.069)	(0.167)			(0.069)	(0.244)		

US studies (e.g., Faulkender et al., 2008, 2012; Leary and Roberts, 2005). Further, the increase in debt maturity with tangible and intangible assets is evidence that the two forms of corporate assets play a similar role in facilitating access to debt financing.[28] The negative effect of non-debt tax shield and volatility on debt maturity is consistent with firms substituting debt tax shield for non-debt tax shield, and the need to avoid bankruptcy, which increases with earnings volatility.

Overall, the differences in the determinants of debt maturity between innovative and non-innovative firms are insignificant, except for R&D. R&D has a significant positive effect on long-term debt with maturity greater than one and three years, but its effect diminishes with maturity. Further, the coefficients on lagged debt maturity show low persistence in debt maturity for innovative firms than non-innovative firms for debt with maturity greater than one year, but this difference reverses for debt with maturity greater than three and five years. The change in persistence suggests that innovative firms that use debt tend to prefer debt with long maturity relative to short maturity. The preference for debt with long maturity is consistent with a desire to reduce roll-over risk or high debt overhang associated with short-term debt. Further, the positive effect of intangible assets is consistent with the results in Tables 4.1 and 4.2. These results show that intangible assets support debt financing with this positive effect being relatively higher for innovative firms that have less tangible assets.

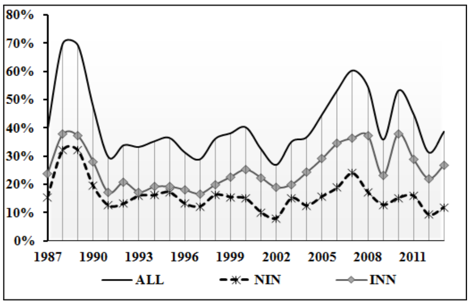
4.4.6 Access to capital markets

This section investigates the determinants of equity and debt issues or repurchases. Figure 4.3 presents time series plots of new equity and debt issues and repurchases. The high frequency of equity and debt issues or retirements is apparent and shows that firms in the UK actively adjust capital structure. This is inconsistent with a

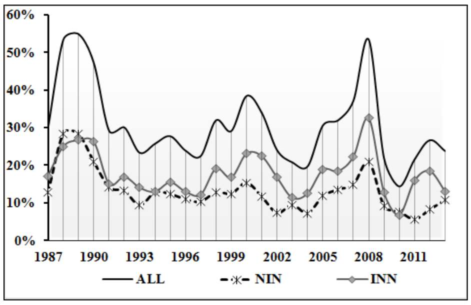
[28] Appendix 4.B shows that debt maturity has been increasing in the UK. This increase in debt maturity is inconsistent with Custódio et al. (2013) who report marked decreases in debt maturity in the US over the period 1976-2008 due to the increase the proportion of small firms and firms with high information asymmetry problems. In the presence of high information asymmetry, shortening debt maturity is optimal as it allows for opportunities to refinance at lower costs if the conditions of the firm or economic environment improves.

Figure 4.3 The evolution of issues and repurchases

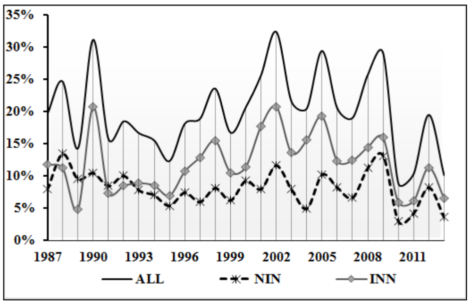
(a) Equity issues



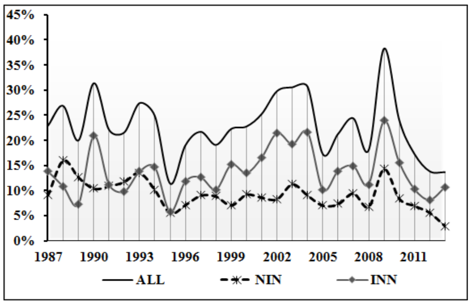
(b) Debt issues



(c) Equity repurchases



(d) Debt retirements



study in the US by Lemmon et al. (2008) and in economies in transition by Hanousek and Shamshur (2011), who report that leverage is largely persistent and stable over time. In contrast to these two studies, DeAngelo and Roll (2015) report that firms actively adjust capital structure, with similarities for firms that have the same initial capital structure disappearing over time. Figure 4.3 shows that innovative firms have relatively high equity and debt issues or repurchases than non-innovative firms. This result suggests that innovative firms are more active in adjusting capital structure, contrary to theoretical prediction by Dittmar and Thakor (2007) that equity issues decrease with information asymmetry, while debt issues tend to increase with information asymmetry. However, the regular access of capital markets by innovative firms is consistent with the predictions of the trade-off theory, which posits that deviations from the target capital structure are more costly for firms with high information asymmetry. Further, the result also show that publicly listed innovative firms face less credit constraints as they more able to access capital markets than non-listed firms.

Table 4.4 presents the results of estimating multivariate logistic regressions of Equa-

Table 4.4 Access to capital markets

The table presents estimation results of Equation (4.3) that relates the probability of issuing or repurchasing equity or debt to research and development (R&D), capital expenditure (Capex), tangible assets, intangible assets, size, profit, non-debt tax shield, and earnings volatility. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Panel A: Equity and debt issues

	Issue Equity			Issue Debt		
Variables	ALL	NIN	INN	ALL	NIN	INN
R&D	1.789***		1.395***	-0.820		-1.204**
	(0.525)		(0.523)	(0.576)		(0.590)
Capex	1.833***	1.663***	2.113***	3.027***	3.093***	3.165***
	(0.413)	(0.548)	(0.638)	(0.398)	(0.528)	(0.628)
Tangible	-0.526***	-0.293	-0.803***	-0.033	-0.163	-0.065
	(0.155)	(0.226)	(0.220)	(0.140)	(0.206)	(0.199)
Intangible	0.467***	0.554**	0.437**	0.163	0.313	0.049
	(0.138)	(0.233)	(0.175)	(0.127)	(0.210)	(0.165)
Size	-0.076***	-0.058**	-0.080***	-0.035***	-0.067***	-0.020
	(0.011)	(0.023)	(0.014)	(0.010)	(0.021)	(0.012)
Profit	2.186***	2.798***	1.904***	1.504***	1.897***	1.296***
	(0.169)	(0.313)	(0.201)	(0.182)	(0.318)	(0.220)
NDTS	-2.121**	-3.241**	-1.705	-5.023***	-4.386***	-5.196***
	(0.895)	(1.383)	(1.190)	(0.876)	(1.322)	(1.190)
Volatility	0.920**	0.617	1.076**	0.121	-0.996	0.579
	(0.359)	(0.656)	(0.428)	(0.367)	(0.655)	(0.435)
Constant	0.968***	0.523	1.293***	-0.294	0.188	-0.508**
	(0.204)	(0.353)	(0.265)	(0.179)	(0.320)	(0.227)
N	7579	2945	4634	7579	2945	4634

Panel B: Equity and debt repurchases

	Repurchase Equity			Retire Debt		
Variables	ALL	NIN	INN	ALL	NIN	INN
R&D	0.734		0.753	-3.486***		-3.662***
	(0.501)		(0.506)	(0.659)		(0.682)
Capex	-0.557	-0.480	-0.738	-0.781*	-0.975*	-0.918
	(0.490)	(0.679)	(0.734)	(0.452)	(0.587)	(0.714)
Tangible	-0.136	-0.061	-0.135	0.078	0.317	-0.127
	(0.166)	(0.249)	(0.232)	(0.153)	(0.210)	(0.220)
Intangible	-0.047	0.181	-0.205	0.084	-0.051	0.118
	(0.145)	(0.237)	(0.191)	(0.135)	(0.212)	(0.174)
Size	0.013	0.023	0.014	0.020*	0.006	0.026**
	(0.011)	(0.023)	(0.014)	(0.011)	(0.021)	(0.013)
Profit	-1.195***	-1.273***	-1.152***	-1.726***	-1.960***	-1.538***
	(0.172)	(0.302)	(0.208)	(0.182)	(0.307)	(0.225)
NDTS	2.131**	2.803*	1.601	3.912***	2.746**	4.859***
	(0.937)	(1.440)	(1.266)	(0.883)	(1.296)	(1.196)
Volatility	1.885***	1.704***	1.834***	0.884**	1.056	0.848*
	(0.390)	(0.645)	(0.499)	(0.373)	(0.645)	(0.450)
Constant	-1.407***	-1.341***	-1.648***	-1.161***	-1.216***	-1.086***
	(0.210)	(0.355)	(0.292)	(0.194)	(0.323)	(0.246)
N	7579	2945	4634	7579	2945	4634

tion (4.3) with a binary dependant variable taking the value of one each year a firm issues or repurchases equity or debt, and zero otherwise. Issues or repurchases of equity or debt are defined as any net change in equity or debt that is in excess of 5% as in Hovakimian et al. (2001), Hovakimian and Vulanovic (2010) and Korajczyk and Levy (2003). The results in Table 4.4 Panel A, show that the probability of conducting new equity issues increases with R&D and capital expenditure, while the probability of issuing debt decreases with R&D and increases with capital expenditure. The positive effect of R&D on equity issues and negative effect on the probability of issuing debt is consistent with the proposition that firms with low collateral values, and which are prone to information asymmetry and asset substitution problems face binding financial constraints (see, Brown and Petersen, 2009, 2011; Moshirian et al., 2013). According to O'Brien (2003), the need to preserve flexibility (by avoiding stringent debt covenants associated with leverage) favours equity financing.

Capital expenditure has a consistent and significant positive effect on the probability of issuing equity and debt. Investment in physical assets reduces information asymmetry as collateral values increase. Similarly, Berger et al. (2011) report that a decrease in information asymmetry among firms in the US reduces the need to pledge more collateral. Further, Campello and Giambona (2013) recently report that tangible assets that are easily redeployable facilitate borrowings the most, especially, in bad macroeconomic environments. Consistently, the positive effect of capital expenditure on the probability of issuing equity and debt is relatively higher for innovative firms than non-innovative firms. This suggests that further investments in tangible assets are more valuable in reducing information asymmetry for innovative firms.

The results on control variables are mixed. Tangible assets have a significant negative effect on new equity issues, but no significant effects on debt issues. This result is surprising and inconsistent with Hovakimian et al. (2004) and Hovakimian and Vulanovic (2010) who report a significant positive effect of tangibility on issuance decisions of firms in the US. Intangible assets have a significant positive effect on equity issues, with this effect being larger for innovative firms than non-innovative firms. However, intangible assets have no significant effects on the probability of issuing debt. Size and non-debt tax shield have a consistently negative effect on equity issues and debt issues. Profitability has a consistent and significant positive effect on the probability of issuing debt and equity, while volatility has a positive significant effect on equity issues, but this effect is rather insignificant for non-innovative firms.

This result supports the pecking order theory, which posits that firms significantly reduce external financing with increases in profitability. The effect of volatility on debt issues is insignificant.

The results in Panel B show that there are no significant differences in the probability of repurchasing equity or debt conditional on having new investments, except for profitability and volatility. The insignificant coefficients mean that the probability of conducting equity repurchases is not greatly influenced by R&D, capital expenditure, size, tangible assets or intangible assets. The probability of repurchasing equity significantly decreases with profitability, and increases with volatility as is consistent with the need to reduce bankruptcy costs. The effects of the determinants of equity repurchases are rather similar for innovative and non-innovative firms.

Overall, the results in Table 4.4 show that there are significant differences on the determinants of the probability of issuing equity and debt, but not on repurchasing debt or equity between innovative and non-innovative firms.

4.5 Robustness tests

This section presents a number of robustness checks. Table 4.5 presents estimation results of Equation (4.2) in five sub-periods. Table 4.6 presents estimation results of the probability of issuing equity and debt.

In order to analyse the sensitivity of the results to sample period selection, Table 4.5 presents results for five sub-periods. The overall sample period is divided into four non-overlapping five-year sub-periods and a final three-year period (2011-2013). The results in Table 4.5 show that there are significant changes in the coefficients on the determinants of leverage over time. In particular, the negative effect of R&D on leverage decreases up to the period 2005-2010, after which it increases significantly, along with increased risk aversion in the post-global financial crisis period and with the time series plots from the rolling regressions in Figure 4.1. The coefficients on

Table 4.5 Dynamics in leverage determinants

The table presents the results of estimating Equation (4.2) that relates leverage to lagged leverage, research and development (R&D), capital expenditure (Capex), tangible assets, intangible assets, growth, size, profit, non-debt tax shield, and earnings volatility. TDA is total debt to total assets, NDA is net-debt to total assets, LTDA is long-term debt to total assets and TLTA is total liabilities to total assets. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in 3.2 in Chapter 3, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. The results are estimated via system GMM. The table reports the *J statistic* from a test of the over identifying restrictions, and the *J statistic* is asymptotically distributed as chi-squared under the null of instrument validity, and the test of second-order autocorrelation (*m2*) in the first differenced residuals. Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

PANEL A: Total debt and net-debt

	TDA					**NDA**				
Variables	I	II	III	IV	V	VI	VII	VIII	IX	X
Lev_{it-1}	0.689***	0.715***	0.783***	0.691***	0.611***	0.658***	0.643***	0.736***	0.590***	0.406*
	(0.084)	(0.067)	(0.064)	(0.068)	(0.124)	(0.097)	(0.076)	(0.059)	(0.072)	(0.235)
R&D	-0.286***	-0.225**	-0.166**	-0.111*	-0.379***	-0.194	-0.382*	-0.161	-0.129	-0.396**
	(0.083)	(0.088)	(0.071)	(0.057)	(0.087)	(0.140)	(0.215)	(0.132)	(0.124)	(0.174)
Capex	0.171**	0.048	0.132**	0.129**	0.106	0.218***	0.014	0.166	0.283***	0.277**
	(0.072)	(0.059)	(0.065)	(0.058)	(0.123)	(0.069)	(0.092)	(0.103)	(0.097)	(0.128)
Tangible	0.016	0.048***	0.091***	0.080***	0.068**	0.165***	0.217***	0.285***	0.213***	0.258**
	(0.019)	(0.017)	(0.025)	(0.023)	(0.032)	(0.035)	(0.036)	(0.047)	(0.040)	(0.103)
Intangible	0.029	0.095***	0.120***	0.044***	0.020	0.178**	0.294***	0.306***	0.216***	0.208**
	(0.049)	(0.029)	(0.027)	(0.016)	(0.030)	(0.071)	(0.057)	(0.040)	(0.038)	(0.088)
Growth	0.003	0.004	-0.002	-0.003	-0.001	-0.003	-0.002	-0.002	-0.013*	-0.008
	(0.004)	(0.003)	(0.001)	(0.003)	(0.003)	(0.006)	(0.006)	(0.003)	(0.008)	(0.011)
Size	0.007***	0.004***	0.003**	0.005***	0.010***	0.001	-0.001	0.002	0.005**	0.011**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.005)
Profit	-0.283***	-0.215***	-0.149***	-0.177***	-0.203***	-0.295***	-0.289***	-0.181***	-0.189***	-0.167**
	(0.056)	(0.021)	(0.029)	(0.030)	(0.037)	(0.073)	(0.038)	(0.039)	(0.049)	(0.069)
NDTS	-0.492***	-0.208*	-0.351**	-0.137	-0.102	-0.528**	-0.198	-0.393**	-0.162	-0.070
	(0.158)	(0.120)	(0.143)	(0.113)	(0.135)	(0.231)	(0.171)	(0.178)	(0.141)	(0.244)
Volatility	0.047	-0.202***	-0.157**	0.020	0.207**	-0.025	-0.387***	-0.299***	0.024	0.198
	(0.108)	(0.054)	(0.064)	(0.068)	(0.088)	(0.147)	(0.099)	(0.079)	(0.078)	(0.128)
Constant	0.015	0.016	-0.038	-0.057**	-0.106***	0.025	-0.005	-0.161***	-0.190***	-0.290***
	(0.026)	(0.018)	(0.023)	(0.023)	(0.032)	(0.038)	(0.031)	(0.037)	(0.046)	(0.101)
Sample	1987-1992	1993-1998	1999-2004	2005-2010	2011-2013	1987-1992	1993-1998	1999-2004	2005-2010	2011-2013
N	1585	2488	1568	1361	577	1585	2488	1568	1361	577
m2	0.514	0.020	2.066	-0.094	0.328	0.379	-0.800	0.789	-0.934	-0.112
p-value	(0.607)	(0.984)	(0.039)	(0.925)	(0.743)	(0.705)	(0.424)	(0.430)	(0.350)	(0.911)
J	3.426	18.593	20.403	15.666	11.691	2.330	23.750	12.768	13.918	21.713
p-value	(0.843)	(0.352)	(0.254)	(0.548)	(0.166)	(0.939)	(0.126)	(0.752)	(0.673)	(0.005)

Table 4.5 Dynamics in leverage determinants (continued)

PANEL B: Long-term debt and total liabilities

	LTDA					TLTA				
Variables	I	II	III	IV	V	VI	VII	VIII	IX	X
Lev_{it-1}	0.768***	0.793***	0.616***	0.573***	0.627***	0.597***	0.745***	0.830***	0.570***	0.798***
	(0.068)	(0.049)	(0.099)	(0.074)	(0.120)	(0.113)	(0.083)	(0.057)	(0.146)	(0.141)
R&D	-0.159**	-0.058	-0.091*	-0.069*	-0.212***	-0.244**	-0.499**	-0.313***	-0.387***	-0.302***
	(0.072)	(0.067)	(0.054)	(0.040)	(0.067)	(0.112)	(0.201)	(0.094)	(0.132)	(0.105)
Capex	0.077	0.048	0.036	0.016	0.162	0.015	0.008	0.064	-0.042	0.243**
	(0.076)	(0.042)	(0.054)	(0.074)	(0.108)	(0.063)	(0.064)	(0.060)	(0.083)	(0.109)
Tangible	0.053***	0.052***	0.074***	0.116***	0.088***	-0.058	-0.035	-0.023	-0.017	-0.037
	(0.019)	(0.014)	(0.026)	(0.022)	(0.028)	(0.042)	(0.029)	(0.031)	(0.038)	(0.054)
Intangible	0.083*	0.085***	0.129***	0.074***	0.059**	-0.024	-0.025	-0.014	-0.050	-0.056
	(0.049)	(0.029)	(0.029)	(0.018)	(0.028)	(0.058)	(0.036)	(0.027)	(0.039)	(0.042)
Growth	-0.003	-0.003	0.000	0.001	-0.003	0.008	0.013***	0.001	0.003	0.007
	(0.004)	(0.002)	(0.001)	(0.003)	(0.003)	(0.007)	(0.005)	(0.002)	(0.007)	(0.006)
Size	0.005***	0.002**	0.006***	0.008***	0.010***	0.009***	0.008***	0.007***	0.012***	0.011***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Profit	-0.071	-0.028*	-0.066***	-0.114***	-0.127***	-0.193***	-0.336***	-0.254***	-0.274***	-0.341***
	(0.051)	(0.016)	(0.016)	(0.022)	(0.025)	(0.064)	(0.029)	(0.033)	(0.046)	(0.049)
NDTS	-0.362**	-0.288***	-0.057	-0.088	-0.166	0.162	0.292	0.264**	0.344*	0.175
	(0.168)	(0.089)	(0.107)	(0.114)	(0.170)	(0.228)	(0.225)	(0.134)	(0.198)	(0.176)
Volatility	0.017	-0.038	-0.104**	0.031	0.151*	0.233	-0.206***	-0.116**	-0.112	-0.040
	(0.110)	(0.035)	(0.048)	(0.044)	(0.084)	(0.155)	(0.072)	(0.048)	(0.073)	(0.092)
Constant	-0.034	-0.025*	-0.077***	-0.116***	-0.129***	0.085	0.038	-0.001	0.021	-0.064
	(0.022)	(0.014)	(0.027)	(0.024)	(0.030)	(0.057)	(0.036)	(0.025)	(0.048)	(0.063)
Sample	1987-1992	1993-1998	1999-2004	2005-2010	2011-2013	1987-1992	1993-1998	1999-2004	2005-2010	2011-2013
N	1585	2488	1568	1361	577	1585	2488	1568	1361	577
$m2$	0.097	0.850	-0.685	0.171	1.408	-1.448	0.861	0.545	-1.758	-0.652
p-value	(0.922)	(0.395)	(0.493)	(0.864)	(0.159)	(0.148)	(0.389)	(0.586)	(0.079)	(0.515)
J	5.009	16.749	23.602	14.218	6.765	2.045	21.421	22.025	21.721	4.818
p-value	(0.659)	(0.471)	(0.131)	(0.652)	(0.562)	(0.957)	(0.208)	(0.184)	(0.196)	(0.777)

capital expenditure are only significant for total debt and net-debt, with this significance changing over time. The capital expenditure has an insignificant effect on long-term debt and total liabilities, which suggests that capital expenditure affects capital structure decisions mostly through it's effect on short-term debt.[29] Consistent with the results in the previous sections of this chapter, tangible and intangible assets have a significant and similar effect on leverage, except for total liabilities where the effect of corporate assets is consistently negative and insignificant. This shows that intangible assets support debt financing in a similar way as tangible assets. Similar variations are observable on the coefficients on the control variables, with size and profitability being the only factors that remain consistently significant over time, except for net-debt.

Appendix 4.C presents the results of estimating Equation (4.2) using OLS, OLS with fixed effects (OLS-FE), and the Anderson Hsiao Instrumental Variables (AH-IV) method. The dynamic models in Appendix 4.D are estimations of Equation (4.2) using Instrumental Variable GMM (IV-GMM), Difference GMM (DIFF-GMM), and an unbalanced dynamic panel data with a fractional dependent variable (DPF thereon) estimator.[30] These results are presented to facilitate comparisons with previous studies that use a similar approach and for robustness. Overall, the results in Appendices 4.C and 4.D remain qualitatively similar in terms of both signs and significance, which suggests that the results in this chapter are robust. Appendix 4.E shows that the results remain qualitatively similar for the balanced sample in which firms with any missing observation are excluded.

Table 4.6 presents the results of estimating Equation (4.3) that relates the probability of issuing equity or debt to firm specific factors. The probability of issuing debt or

[29]Consistent with the result in Table 4.5, the plots time series correlations in Appendix 3.C show a marked increase the correlation between short-term debt and capital expenditure for the period, with the correlations for the rest of the sample period being insignificant and close to zero.

[30]A number of studies (e.g., Chang and Dasgupta, 2009; Elsas and Florysiak, 2011; Iliev and Welch, 2010) highlight the need to consider the fractional nature of leverage (leverage is ratio bounded in the interval [0,1]) in dynamic models of capital structure so as not to overstate the results. According to Elsas and Florysiak (2011) and Elsas and Florysiak (2013), the DPF estimator controls for the fractional nature of leverage.

Table 4.6 Access to capital markets : Other methods

The table presents the results of estimating Equation (4.3), the probability of issuing equity or debt to research and development (R&D), capital expenditure (Capex), tangible assets, intangible assets, size, profit, non-debt tax shield, and earnings volatility. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are :d in Table 3.2, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	Issue Equity			Issue Debt		
Variables	ALL	NIN	INN	ALL	NIN	INN
R&D	3.163**		2.967**	-1.461**		-1.346**
	(1.341)		(1.410)	(0.659)		(0.666)
Capex	1.904***	1.935***	2.414***	1.504***	1.097*	2.115***
	(0.502)	(0.608)	(0.878)	(0.475)	(0.628)	(0.743)
Tangible	-0.650***	-0.824**	-0.665**	0.478***	0.173	0.818***
	(0.237)	(0.351)	(0.337)	(0.177)	(0.254)	(0.253)
Intangible	0.654**	1.032***	0.552	0.183	0.338	0.288
	(0.261)	(0.383)	(0.347)	(0.191)	(0.282)	(0.258)
Size	0.208***	0.214***	0.200***	0.144***	0.163***	0.139***
	(0.020)	(0.039)	(0.024)	(0.013)	(0.025)	(0.016)
Profit	0.979***	0.940*	1.021***	0.175	0.808***	-0.148
	(0.260)	(0.507)	(0.303)	(0.186)	(0.279)	(0.227)
NDTS	-0.163	1.948	-1.451	-2.587**	-2.151	-3.620**
	(1.357)	(1.901)	(1.916)	(1.005)	(1.443)	(1.462)
Volatility	0.007	-2.145***	1.241*	-0.169	-0.591	-0.032
	(0.597)	(0.742)	(0.675)	(0.337)	(0.592)	(0.446)
Constant	-2.507***	-2.833***	-2.053***	-1.269***	-1.268***	-1.404***
	(0.369)	(0.612)	(0.447)	(0.246)	(0.444)	(0.305)
N	7579	2945	4622	7579	2945	4603

equity is captured by a dummy variable that takes the value of one if a firm reports debt or equity issues (Datastream account items WC04401 and WC04251) and zero otherwise. The results in Table 4.6 are consistent with those of Table 4.4, except for size which changes to have a positive effect on the probability of issuing equity and debt. Consistent with the predictions of the information asymmetry model, the probability of issuing equity increases with R&D while the probability of issuing debt decreases with R&D. Similar to the results in Table 4.4, the probability of issuing debt and equity increases with capital expenditure. This is consistent with the theoretical predictions (e.g., Holmstrom and Tirole, 1997; Leland and Pyle, 1977; Leland, 1998) that collateral reduces information asymmetry problems which increases flexibility in adjusting capital structure. Overall, the results are robust to different sample period selection, different estimation techniques, and variable definitions.

4.6 Conclusions

The analysis in this chapter uses a de-compositional approach to investigate the differences in financing decisions of innovative and non-innovative firms in the UK over the period 1987-2013. This de-compositional approach allows for a more detailed analysis of financing decisions and the determinants of leverage. If investment type is of first order importance to corporate financial decisions, then the increase in R&D and decrease in collateral values, should result in significant reductions in corporate debt. Contrary to this prediction, leverage and debt maturity have remained persistent in the UK, with an upward drift. This persistence indicates that innovative firms are able to access debt financing in similar ways to non-innovative firms.

The results show that innovative and non-innovative firms adopt similar financing policies, which suggests that innovative firms are able to access debt financing despite their focus on investments in R&D and intangible assets. The analysis in this chapter shows that R&D is inversely related to leverage, while capital expenditure is positively related to leverage. This inverse relation between debt financing and R&D supports the predictions of the information asymmetry theory that problems (high information asymmetry, asset substitution, high specificity and low collateral values) associated with intangible investments favour internal or equity financing over debt financing. However, innovative firms follow similar financing structures as non-innovative firms, but with relatively lower proportions of debt financing from 2000 onwards. The persistence in leverage and the similarity of financing structures between innovative and non-innovative firms despite the increasing R&D expenditure and decreasing collateral values, suggest that innovation is financed with debt. This is contrary to the theoretical and empirical predictions that equity is the most preferred source of financing for innovation (see, Brown et al., 2009; Brown and Petersen, 2014; Hall, 2002; Krainer, 2014; Parthiban et al., 2008). Further, the positive relationship between intangible assets and leverage also suggests that intangible assets play a similar role as tangible assets in facilitating access to debt financing. Comparisons of the determinants of leverage show that capital expenditure has consistently insignificant effect on leverage for innovative firms, while it has a significant positive effect for non-innovative firms. Similar significant differences are observable on tangible assets and intangible assets. Both tangible assets and intangible assets have a significantly higher positive effect for innovative firms than non-innovative firms. These differences remain significant even after controlling for other standard determinants of leverage, and suggests that accounting for the heterogeneity in corporate investment is important in the understanding of between financing decisions.

The analysis in this chapter also presents evidence that there are significant time variations in the effect of investment (R&D and capital expenditure) and corporate assets (intangible/tangible assets) on leverage. The coefficients on R&D and capital expenditure vary over time, for different measures of leverage, and across innovative and non-innovative firms. These variations in part help explain the mixed results reported in the literature. The results show a decreasing negative effect of R&D on leverage up to the period 2005-2010, after which it increases significantly. This implies an increase in the use of leverage by innovative firms. At the same time, the positive effect of capital expenditure on leverage follows a general upward trend over the period 1993 to 2013. This result suggests a significant decrease in debt overhang concerns as managers finance physical capital investments using debt. Similar changes are also observed on corporate assets, with both intangible and tangible assets having a consistent positive effect on leverage, but this effect is significantly higher for innovative firms than non-innovative firms. The higher positive effect of corporate assets on debt for innovative firms shows that collateral plays a more significant role in facilitating access to debt financing for firms that face binding financial constraints. Further, the results show that intangible assets are used as a form of collateral similar to tangible assets in order to facilitate access to debt financing. These time and cross sectional variations in the coefficients on investment and corporate assets show that the relationship between leverage and investment, and between leverage and corporate assets is dynamic and differs across innovative and non-innovative firms.

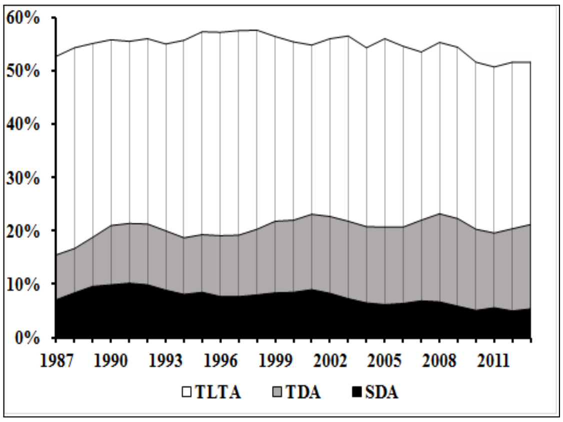
Overall, the results show that investment and corporate assets have a significant and dynamic effect on corporate financing decisions, even after controlling for standard determinants of capital structure. Further research on the interactions of financing and investment decisions can add insights in understanding the time and cross-sectional variations in capital structure.

Appendices to Chapter 4

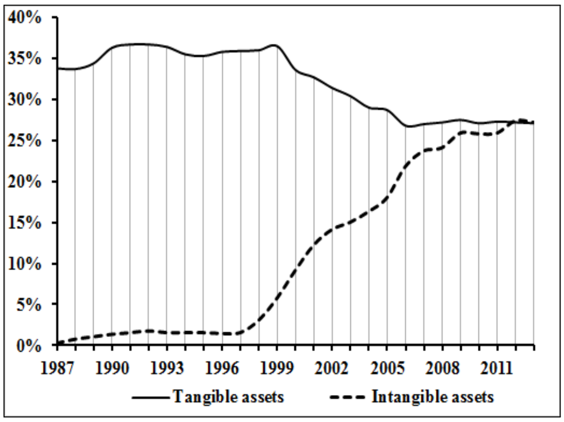
Appendix 4.A Corporate debt and asset structure

ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1$^{\text{th}}$ and 99$^{\text{th}}$ percentiles. The data is drawn from Worldscope through Datastream.

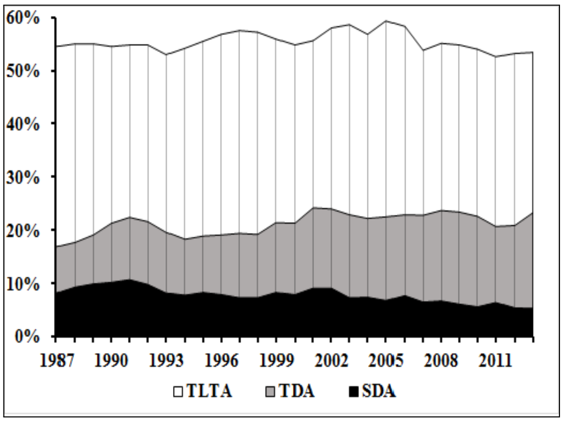
(a) All



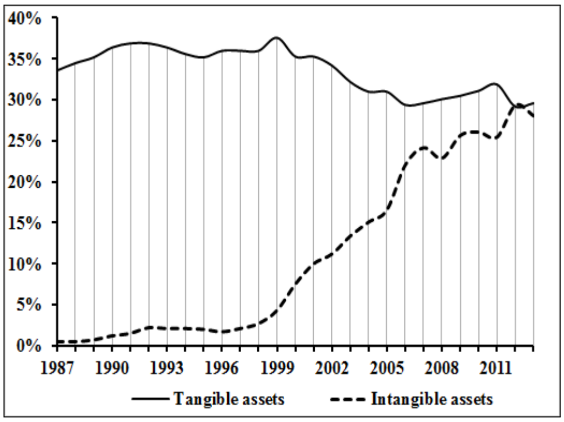
(b) All



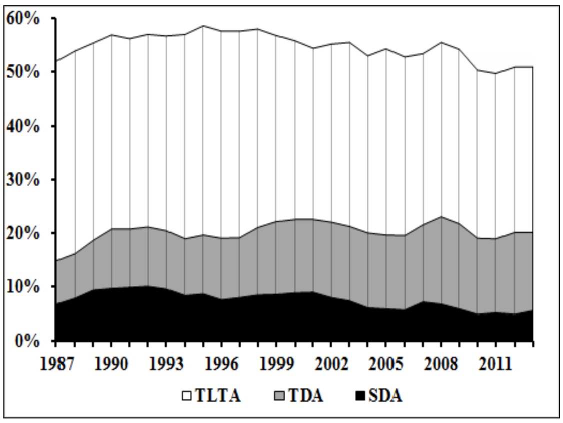
(c) NIN



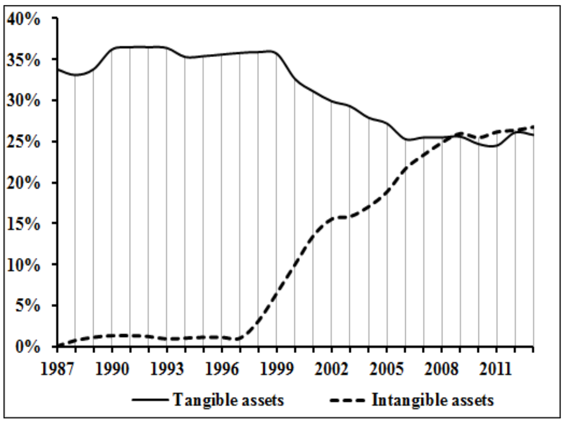
(d) NIN



(e) INN



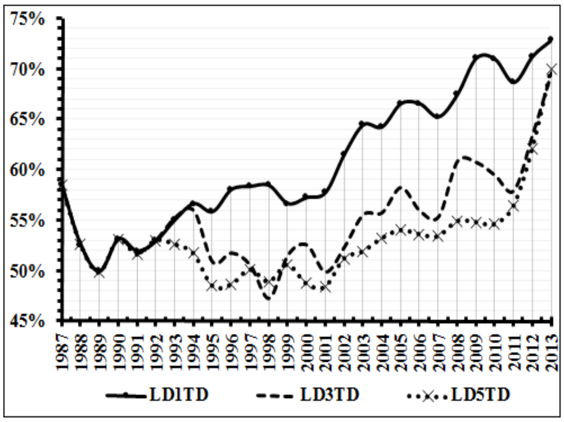
(f) INN



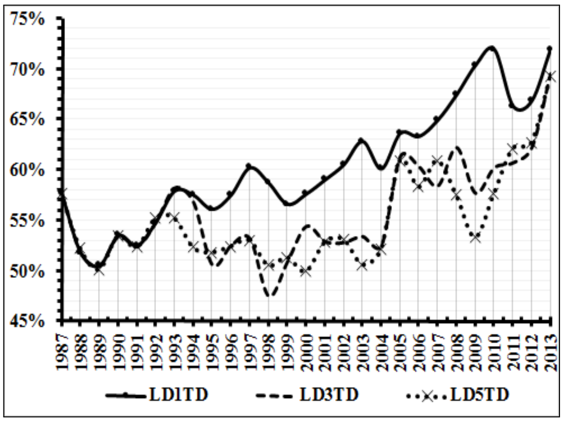
Appendix 4.B Corporate debt maturity

ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream.

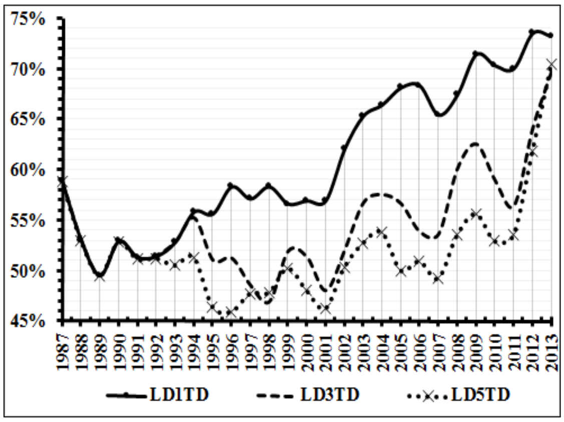
(a) All



(b) NIN



(c) INN



Appendix 4.C Leverage and investment using other methods

The table presents the results of estimating Equation (4.1) that relates leverage to lagged leverage, research and development (R&D), capital expenditure (Capex), tangible assets, intangible assets, growth, size, profit, non-debt tax shield, and earnings volatility. TDA is total debt to total assets, NDA is net-debt to total assets, LTDA is long-term debt to total assets and TLTA is total liabilities to total assets. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. The results are estimated by OLS, OLS-FE and Anderson Hsiao Instrumental Variables (AH-IV). Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Panel A: ALL

Variables	TDA	NDA	LTDA	TLTA	TDA	NDA	LTDA	TLTA	TDA	NDA	LTDA	TLTA
Lev_{it-1}									0.861***	0.852***	0.844***	0.915***
									(0.013)	(0.014)	(0.015)	(0.011)
R&D	-0.396***	-0.823***	-0.180***	-0.694***	-0.308***	-0.276	-0.094	-0.362**	-0.085***	-0.081	-0.016	-0.174***
	(0.034)	(0.085)	(0.025)	(0.066)	(0.094)	(0.176)	(0.059)	(0.161)	(0.033)	(0.050)	(0.024)	(0.044)
Capex	0.034	-0.018	0.068**	0.029	-0.006	-0.010	0.003	-0.029	0.179***	0.238***	0.102***	0.097**
	(0.039)	(0.050)	(0.033)	(0.049)	(0.039)	(0.052)	(0.030)	(0.050)	(0.034)	(0.055)	(0.030)	(0.038)
Tangible	0.090***	0.301***	0.126***	-0.202***	0.142***	0.524***	0.143***	-0.040	0.023***	0.092***	0.030***	-0.010
	(0.011)	(0.017)	(0.009)	(0.015)	(0.033)	(0.057)	(0.028)	(0.039)	(0.008)	(0.015)	(0.008)	(0.010)
Intangible	0.110***	0.348***	0.151***	-0.132***	0.132***	0.469***	0.164***	-0.076*	0.039***	0.120***	0.044***	-0.005
	(0.013)	(0.017)	(0.011)	(0.016)	(0.029)	(0.049)	(0.027)	(0.040)	(0.009)	(0.014)	(0.010)	(0.010)
Growth	-0.007***	-0.022***	-0.003***	0.001	-0.006***	-0.012***	-0.003**	0.008	0.001	-0.003	0.000	0.005
	(0.001)	(0.002)	(0.001)	(0.003)	(0.002)	(0.003)	(0.002)	(0.005)	(0.002)	(0.002)	(0.001)	(0.004)
Size	0.012***	0.006***	0.015***	0.020***	0.034***	0.029***	0.024***	-0.003	0.003***	0.002***	0.002***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.007)	(0.009)	(0.005)	(0.008)	(0.001)	(0.001)	0.000	(0.001)
Profit	-0.170***	-0.152***	-0.083***	-0.154***	-0.187***	-0.215***	-0.069***	-0.203***	-0.141***	-0.184***	-0.051***	-0.265***
	(0.018)	(0.028)	(0.011)	(0.028)	(0.019)	(0.031)	(0.012)	(0.025)	(0.016)	(0.024)	(0.010)	(0.024)
NDTS	-0.098	0.027	-0.142**	0.846***	-0.179	0.110	-0.154	0.242	-0.142***	-0.158**	-0.162***	0.249***
	(0.077)	(0.102)	(0.061)	(0.106)	(0.126)	(0.163)	(0.099)	(0.164)	(0.052)	(0.069)	(0.046)	(0.074)
Volatility	0.042	-0.077	-0.032	0.117*	0.032	-0.123	-0.011	0.026	-0.124***	-0.257***	-0.074***	-0.176***
	(0.040)	(0.062)	(0.022)	(0.066)	(0.060)	(0.090)	(0.032)	(0.085)	(0.031)	(0.050)	(0.021)	(0.039)
Constant	-0.018	-0.136***	-0.158***	0.194***	-0.243***	-0.404***	-0.237***	0.588***	0.006	-0.024	-0.001	0.034**
	(0.016)	(0.023)	(0.012)	(0.022)	(0.083)	(0.106)	(0.065)	(0.099)	(0.010)	(0.016)	(0.011)	(0.016)
Method	OLS	OLS	OLS	OLS	FE	FE	FE	FE	AH-IV	AH-IV	AH-IV	AH-IV
N	8396	8396	8396	8396	8396	8396	8396	8396	5128	5128	5128	5128
$Adj.R^2$	0.173	0.237	0.264	0.177	0.135	0.205	0.101	0.065	0.721	0.709	0.692	0.782

Appendix 4.C Leverage and investment: Other methods (continued)

Panel B: NIN

Variables	TDA	NDA	LTDA	TLTA	TDA	NDA	LTDA	TLTA	TDA	NDA	LTDA	TLTA
Lev_{it-1}									0.873***	0.856***	0.852***	0.938***
									(0.022)	(0.022)	(0.026)	(0.016)
Capex	0.062	0.011	0.104**	0.169***	0.010	-0.004	0.027	0.033	0.236***	0.273***	0.113***	0.230***
	(0.055)	(0.067)	(0.047)	(0.063)	(0.046)	(0.049)	(0.038)	(0.049)	(0.055)	(0.083)	(0.042)	(0.059)
Tangible	0.076***	0.204***	0.110***	-0.217***	0.133***	0.431***	0.134***	-0.069	0.007	0.056***	0.018	-0.024*
	(0.017)	(0.022)	(0.015)	(0.019)	(0.044)	(0.070)	(0.037)	(0.045)	(0.012)	(0.019)	(0.012)	(0.014)
Intangible	0.141***	0.321***	0.158***	-0.077***	0.163***	0.482***	0.173***	-0.012	0.023	0.084***	0.027	-0.007
	(0.020)	(0.026)	(0.018)	(0.024)	(0.053)	(0.083)	(0.051)	(0.062)	(0.017)	(0.024)	(0.017)	(0.015)
Growth	-0.013***	-0.035***	-0.005***	0.001	-0.005	-0.015**	-0.002	0.017***	0.002	-0.003	0.000	0.012**
	(0.003)	(0.005)	(0.002)	(0.004)	(0.005)	(0.006)	(0.003)	(0.006)	(0.002)	(0.003)	(0.002)	(0.005)
Size	0.016***	0.009***	0.025***	0.015***	0.039***	0.050***	0.029***	0.013	0.003***	0.002*	0.004***	0.002
	(0.002)	(0.002)	(0.001)	(0.002)	(0.011)	(0.013)	(0.009)	(0.012)	(0.001)	(0.001)	(0.001)	(0.001)
Profit	-0.194***	-0.230***	-0.072***	-0.232***	-0.210***	-0.261***	-0.079***	-0.247***	-0.195***	-0.232***	-0.058***	-0.335***
	(0.025)	(0.037)	(0.019)	(0.033)	(0.025)	(0.039)	(0.020)	(0.027)	(0.021)	(0.040)	(0.020)	(0.031)
NDTS	-0.374***	-0.276**	-0.325***	0.667***	-0.276	-0.083	-0.279*	-0.102	-0.141**	-0.211**	-0.131*	0.064
	(0.115)	(0.139)	(0.097)	(0.152)	(0.201)	(0.199)	(0.155)	(0.219)	(0.071)	(0.099)	(0.076)	(0.103)
Volatility	0.029	-0.101	-0.019	0.143**	0.049	-0.095	-0.015	0.095	-0.186***	-0.307***	-0.101***	-0.209***
	(0.050)	(0.070)	(0.038)	(0.067)	(0.074)	(0.102)	(0.064)	(0.091)	(0.039)	(0.067)	(0.034)	(0.053)
Constant	-0.026	-0.084**	-0.237***	0.232***	-0.276**	-0.565***	-0.275***	0.426***	0.027	0.005	0.011	0.081**
	(0.031)	(0.041)	(0.024)	(0.035)	(0.133)	(0.144)	(0.102)	(0.140)	(0.020)	(0.031)	(0.022)	(0.036)
Method	OLS	OLS	OLS	OLS	FE	FE	FE	FE	AH IV	AH IV	AH IV	AH IV
N	3304	3304	3304	3304	3304	3304	3304	3304	1868	1868	1868	1868
$Adj.R^2$	0.221	0.219	0.343	0.244	0.146	0.207	0.098	0.107	0.779	0.725	0.749	0.796

Appendix 4.C Leverage and investment: Other methods (continued)

Panel C: INN

Variables	TDA	NDA	LTDA	TLTA	TDA	NDA	LTDA	TLTA	TDA	NDA	LTDA	TLTA
Lev_{it-1}									0.853***	0.842***	0.826***	0.910***
									(0.017)	(0.020)	(0.022)	(0.014)
R&D	-0.429***	-0.814***	-0.180***	-0.666***	-0.318***	-0.297*	-0.113**	-0.390**	-0.069*	-0.075	-0.020	-0.134***
	(0.038)	(0.084)	(0.025)	(0.070)	(0.094)	(0.171)	(0.057)	(0.152)	(0.038)	(0.054)	(0.025)	(0.047)
Capex	-0.036	-0.058	-0.032	-0.138*	-0.050	-0.031	-0.041	-0.133	0.125***	0.198***	0.086**	-0.011
	(0.052)	(0.078)	(0.042)	(0.075)	(0.061)	(0.097)	(0.047)	(0.087)	(0.043)	(0.073)	(0.039)	(0.049)
Tangible	0.096***	0.409***	0.133***	-0.198***	0.156***	0.598***	0.149***	-0.007	0.047***	0.143***	0.046***	0.020
	(0.015)	(0.024)	(0.012)	(0.022)	(0.049)	(0.086)	(0.042)	(0.058)	(0.012)	(0.024)	(0.011)	(0.014)
Intangible	0.075***	0.376***	0.130***	-0.181***	0.110***	0.467***	0.149***	-0.112**	0.054***	0.156***	0.057***	0.005
	(0.016)	(0.023)	(0.014)	(0.023)	(0.036)	(0.064)	(0.032)	(0.050)	(0.012)	(0.019)	(0.012)	(0.013)
Growth	-0.004**	-0.016***	-0.001	0.001	-0.007***	-0.010***	-0.003*	0.005	0.000	-0.003	0.000	0.003
	(0.002)	(0.003)	(0.001)	(0.003)	(0.002)	(0.004)	(0.002)	(0.005)	(0.002)	(0.002)	(0.001)	(0.003)
Size	0.011***	0.004***	0.013***	0.021***	0.033***	0.017	0.024***	-0.010	0.002***	0.002	0.002***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.008)	(0.013)	(0.007)	(0.011)	(0.001)	(0.001)	(0.001)	(0.001)
Profit	-0.148***	-0.090**	-0.076***	-0.094***	-0.172***	-0.177***	-0.064***	-0.166***	-0.114***	-0.160***	-0.049***	-0.230***
	(0.023)	(0.036)	(0.013)	(0.035)	(0.028)	(0.045)	(0.016)	(0.037)	(0.022)	(0.029)	(0.011)	(0.027)
NDTS	0.242**	0.463***	0.095	1.201***	-0.085	0.271	-0.039	0.555***	-0.145**	-0.105	-0.189***	0.356***
	(0.095)	(0.142)	(0.069)	(0.142)	(0.160)	(0.240)	(0.127)	(0.209)	(0.070)	(0.094)	(0.056)	(0.091)
Volatility	0.034	-0.076	-0.043*	0.074	0.023	-0.135	-0.007	-0.008	-0.101**	-0.238***	-0.050*	-0.207***
	(0.056)	(0.092)	(0.024)	(0.085)	(0.078)	(0.119)	(0.036)	(0.101)	(0.048)	(0.071)	(0.027)	(0.054)
Constant	-0.027	-0.187***	-0.144***	0.186***	-0.248**	-0.317**	-0.238***	0.647***	-0.032**	-0.093***	-0.029**	-0.016
	(0.019)	(0.030)	(0.014)	(0.029)	(0.105)	(0.152)	(0.082)	(0.136)	(0.013)	(0.021)	(0.013)	(0.017)
Method	OLS	OLS	OLS	OLS	FE	FE	FE	FE	AH IV	AH IV	AH IV	AH IV
N	5092	5092	5092	5092	5092	5092	5092	5092	3260	3260	3260	3260
$Adj.R^2$	0.177	0.281	0.252	0.170	0.131	0.212	0.104	0.059	0.679	0.698	0.646	0.775

Appendix 4.D Dynamic leverage models

The table presents the results of estimating Equation (4.1) that relates leverage to lagged leverage, research and development (R&D), capital expenditure (Capex), tangible assets, intangible assets, growth, size, profit, non-debt tax shield, and earnings volatility. TDA is total debt to total assets, NDA is net-debt to total assets, LTDA is long-term debt to total assets and TLTA is total liabilities to total assets. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. The results are estimated by instrumental variable GMM (IV-GMM), difference GMM (DIFF-GMM) and an unbalanced dynamic panel data with a fractional dependent variable (DPF) estimator. The table reports the *J statistic* from a test of the over identifying restrictions, and the *J statistic* is asymptotically distributed as chi-squared under the null of instrument validity, and the test of second-order autocorrelation (*m2*) in the first differenced residuals. Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Panel A: ALL

Variables	TDA	NDA	LTDA	TLTA	TDA	NDA	LTDA	TLTA	TDA	NDA	LTDA	TLTA
Lev_{it-1}	0.861***	0.851***	0.845***	0.915***	0.411***	0.349***	0.598***	0.253**	0.707***	0.601***	0.709***	0.817***
	(0.014)	(0.015)	(0.020)	(0.011)	(0.065)	(0.055)	(0.068)	(0.104)	(0.012)	(0.012)	(0.013)	(0.012)
R&D	-0.085***	-0.079*	-0.017	-0.174***	-0.198**	-0.059	-0.082	-0.167*	-0.163***	-0.237***	-0.058***	-0.242***
	(0.027)	(0.047)	(0.023)	(0.042)	(0.083)	(0.111)	(0.070)	(0.092)	(0.026)	(0.058)	(0.022)	(0.029)
Capex	0.179***	0.238***	0.101***	0.097**	0.041	0.021	-0.020	-0.033	0.157***	0.223***	0.100***	0.061**
	(0.035)	(0.053)	(0.028)	(0.038)	(0.035)	(0.038)	(0.039)	(0.036)	(0.022)	(0.030)	(0.020)	(0.026)
Tangible	0.023***	0.092***	0.030***	-0.010	0.206***	0.839***	0.218***	0.040	0.051***	0.166***	0.052***	-0.021**
	(0.008)	(0.013)	(0.008)	(0.010)	(0.031)	(0.053)	(0.027)	(0.042)	(0.008)	(0.014)	(0.007)	(0.009)
Intangible	0.039***	0.120***	0.044***	-0.005	0.124***	0.631***	0.147***	-0.010	0.057***	0.183***	0.060***	-0.021**
	(0.009)	(0.014)	(0.010)	(0.011)	(0.037)	(0.058)	(0.035)	(0.047)	(0.009)	(0.013)	(0.007)	(0.009)
Growth	0.001	-0.003	0.000	0.005**	-0.002	-0.002	0.000	0.005	-0.001	-0.003	-0.001	0.003***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)	(0.002)	(0.004)	(0.001)	(0.002)	(0.001)	(0.001)
Size	0.003***	0.002***	0.002***	0.004***	0.103***	0.072***	0.043***	0.068***	0.006***	0.004***	0.005***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.008)	(0.012)	(0.007)	(0.012)	(0.001)	(0.001)	(0.001)	(0.001)
Profit	-0.141***	-0.183***	-0.052***	-0.265***	-0.190***	-0.206***	-0.070***	-0.282***	-0.168***	-0.212***	-0.066***	-0.243***
	(0.015)	(0.023)	(0.011)	(0.020)	(0.020)	(0.024)	(0.013)	(0.030)	(0.008)	(0.012)	(0.007)	(0.010)
NDTS	-0.142***	-0.158**	-0.161***	0.249***	-0.169	-0.127	-0.211*	0.224	-0.207***	-0.323***	-0.160***	0.274***
	(0.051)	(0.074)	(0.048)	(0.069)	(0.121)	(0.164)	(0.112)	(0.207)	(0.044)	(0.064)	(0.038)	(0.048)
Volatility	-0.124***	-0.254***	-0.075***	-0.176***	-0.034	-0.217***	-0.026	0.013	-0.092***	-0.143***	-0.041**	-0.146***
	(0.033)	(0.054)	(0.022)	(0.043)	(0.042)	(0.049)	(0.031)	(0.060)	(0.018)	(0.028)	(0.016)	(0.021)
Constant	-0.014	-0.052***	-0.022**	-0.007					-0.037***	-0.103***	-0.055***	0.007
	(0.011)	(0.016)	(0.011)	(0.014)					(0.012)	(0.020)	(0.010)	(0.013)
Method	IV-GMM	IV-GMM	IV-GMM	IV-GMM	DIFF-GMM	DIFF-GMM	DIFF-GMM	DIFF-GMM	DPF	DPF	DPF	DPF
N	5128	5128	5128	5128	6762	6762	6762	6762	7579	7579	7579	7579
$Adj.R^2$	0.721	0.709	0.692	0.782								
m2					0.914	-0.384	0.898	-0.732				
p-value					(0.361)	(0.701)	(0.369)	(0.464)				
J					33.809	44.765	39.710	58.863				
p-value					(0.909)	(0.524)	(0.732)	(0.097)				

Appendix 4.D Dynamic leverage and investment models (continued)

Panel B: NIN

Variables	TDA	NDA	LTDA	TLTA	TDA	NDA	LTDA	TLTA	TDA	NDA	LTDA	TLTA
Lev_{it-1}	0.873***	0.852***	0.853***	0.939***	0.375***	0.446***	0.789***	0.194	0.763***	0.629***	0.775***	0.805***
	(0.020)	(0.022)	(0.033)	(0.017)	(0.107)	(0.074)	(0.111)	(0.133)	(0.020)	(0.022)	(0.020)	(0.022)
Capex	0.237***	0.280***	0.112***	0.228***	0.051	0.101*	0.001	0.029	0.201***	0.242***	0.114***	0.154***
	(0.055)	(0.081)	(0.040)	(0.059)	(0.053)	(0.058)	(0.065)	(0.046)	(0.030)	(0.040)	(0.027)	(0.034)
Tangible	0.007	0.055***	0.018	-0.023*	0.183***	0.650***	0.215***	-0.016	0.029**	0.132***	0.032***	-0.032***
	(0.011)	(0.017)	(0.012)	(0.014)	(0.042)	(0.075)	(0.038)	(0.049)	(0.012)	(0.020)	(0.010)	(0.012)
Intangible	0.023	0.085***	0.027	-0.008	0.062	0.438***	0.124**	-0.110	0.046***	0.151***	0.039***	-0.014
	(0.015)	(0.026)	(0.019)	(0.020)	(0.054)	(0.091)	(0.054)	(0.089)	(0.013)	(0.021)	(0.011)	(0.013)
Growth	0.002	-0.003	0.000	0.012**	-0.002	-0.007	0.000	0.017**	-0.001	-0.007**	-0.001	0.008***
	(0.002)	(0.003)	(0.002)	(0.005)	(0.004)	(0.005)	(0.004)	(0.007)	(0.002)	(0.003)	(0.001)	(0.002)
Size	0.003***	0.002*	0.004***	0.002	0.102***	0.079***	0.048***	0.096***	0.006***	0.007***	0.007***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.012)	(0.017)	(0.011)	(0.018)	(0.001)	(0.002)	(0.001)	(0.001)
Profit	-0.196***	-0.240***	-0.059***	-0.335***	-0.185***	-0.244***	-0.082***	-0.240***	-0.195***	-0.234***	-0.078***	-0.297***
	(0.023)	(0.041)	(0.019)	(0.030)	(0.026)	(0.030)	(0.021)	(0.033)	(0.013)	(0.018)	(0.012)	(0.015)
NDTS	-0.140*	-0.197*	-0.124	0.054	0.019	0.048	-0.166	-0.029	-0.197***	-0.281***	-0.144***	0.111
	(0.072)	(0.105)	(0.076)	(0.100)	(0.149)	(0.193)	(0.147)	(0.320)	(0.063)	(0.090)	(0.054)	(0.072)
Volatility	-0.187***	-0.309***	-0.104***	-0.207***	-0.001	-0.234**	-0.082	0.123**	-0.125***	-0.147***	-0.073***	-0.127***
	(0.047)	(0.078)	(0.034)	(0.062)	(0.063)	(0.102)	(0.056)	(0.058)	(0.028)	(0.039)	(0.025)	(0.032)
Constant	0.002	-0.025	-0.012	0.033					-0.026	-0.118***	-0.053***	0.040*
	(0.020)	(0.029)	(0.024)	(0.030)					(0.020)	(0.034)	(0.017)	(0.021)
Method	IV GMM	IV GMM	IV GMM	IV GMM	DIFF GMM	DIFF GMM	DIFF GMM	DIFF GMM	DPF	DPF	DPF	DPF
N	1867	1867	1867	1867	2586	2586	2586	2586	2945	2945	2945	2945
$Adj.R^2$	0.779	0.726	0.749	0.796								
$m2$					0.366	-0.015	1.785	-0.774				
p-value					(0.714)	(0.988)	(0.074)	(0.439)				
J					38.067	41.482	40.197	49.323				
p-value					(0.791)	(0.662)	(0.713)	(0.342)				

Appendix 4.D Dynamic leverage and investment models (continued)

Panel C: INN

Variables	TDA	NDA	LTDA	TLTA	TDA	NDA	LTDA	TLTA	TDA	NDA	LTDA	TLTA
Lev_{it-1}	0.853***	0.842***	0.826***	0.910***	0.354***	0.263***	0.407***	0.242*	0.680***	0.581***	0.673***	0.827***
	(0.021)	(0.022)	(0.028)	(0.015)	(0.063)	(0.067)	(0.072)	(0.136)	(0.014)	(0.015)	(0.015)	(0.014)
R&D	-0.070**	-0.076	-0.020	-0.133***	-0.138	-0.027	-0.084	-0.194*	-0.171***	-0.259***	-0.063***	-0.208***
	(0.031)	(0.052)	(0.026)	(0.043)	(0.096)	(0.106)	(0.066)	(0.113)	(0.028)	(0.059)	(0.023)	(0.031)
Capex	0.125***	0.198***	0.086**	-0.011	0.013	-0.034	0.001	-0.050	0.103***	0.191***	0.071**	-0.039
	(0.046)	(0.072)	(0.040)	(0.050)	(0.043)	(0.049)	(0.040)	(0.055)	(0.033)	(0.046)	(0.030)	(0.039)
Tangible	0.047***	0.144***	0.046***	0.019	0.217***	1.001***	0.193***	0.045	0.071***	0.206***	0.066***	-0.006
	(0.011)	(0.020)	(0.011)	(0.014)	(0.047)	(0.061)	(0.034)	(0.066)	(0.012)	(0.019)	(0.010)	(0.012)
Intangible	0.054***	0.156***	0.057***	0.005	0.155***	0.792***	0.179***	0.009	0.058***	0.202***	0.068***	-0.028**
	(0.012)	(0.017)	(0.012)	(0.013)	(0.044)	(0.068)	(0.041)	(0.054)	(0.011)	(0.017)	(0.010)	(0.012)
Growth	0.000	-0.003	0.000	0.003	-0.002	-0.002	0.000	0.001	-0.001	-0.001	0.000	0.001
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.001)	(0.002)	(0.001)	(0.001)
Size	0.002***	0.002	0.002***	0.004***	0.099***	0.055***	0.042***	0.060***	0.006***	0.002**	0.005***	0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.010)	(0.014)	(0.009)	(0.014)	(0.001)	(0.001)	(0.001)	(0.001)
Profit	-0.115***	-0.161***	-0.049***	-0.229***	-0.175***	-0.165***	-0.056***	-0.304***	-0.149***	-0.190***	-0.057***	-0.201***
	(0.019)	(0.028)	(0.013)	(0.023)	(0.028)	(0.031)	(0.015)	(0.051)	(0.011)	(0.016)	(0.009)	(0.012)
NDTS	-0.143**	-0.103	-0.189***	0.355***	-0.285*	-0.287	-0.102	0.420*	-0.174***	-0.292***	-0.139***	0.432***
	(0.070)	(0.103)	(0.059)	(0.092)	(0.170)	(0.229)	(0.155)	(0.240)	(0.062)	(0.091)	(0.052)	(0.066)
Volatility	-0.104**	-0.241***	-0.050	-0.206***	-0.036	-0.195***	-0.003	-0.040	-0.080***	-0.141***	-0.028	-0.174***
	(0.049)	(0.072)	(0.033)	(0.058)	(0.049)	(0.046)	(0.034)	(0.088)	(0.023)	(0.039)	(0.021)	(0.027)
Constant	-0.024*	-0.079***	-0.032**	-0.025					-0.048***	-0.104***	-0.063***	-0.011
	(0.014)	(0.022)	(0.012)	(0.016)					(0.017)	(0.025)	(0.014)	(0.016)
Method	IV GMM	IV GMM	IV GMM	IV GMM	DIFF GMM	DIFF GMM	DIFF GMM	DIFF GMM	DPF	DPF	DPF	DPF
N	3260	3260	3260	3260	4176	4176	4176	4176	4634	4634	4634	4634
$Adj.R^2$	0.679	0.698	0.646	0.775								
$m2$					0.425	-0.593	-0.728	-0.746				
p-value					(0.671)	(0.553)	(0.466)	(0.456)				
J					37.393	45.284	43.015	68.355				
p-value					(0.813)	(0.502)	(0.598)	(0.018)				

Appendix 4.E Balanced sample

The table presents the results of estimating Equation (4.2) that relates leverage to lagged leverage, research and development (R&D), capital expenditure (Capex), tangible assets, intangible assets, growth, size, profit, non-debt tax shield, and earnings volatility. TDA is total debt to total assets, NDA is net-debt to total assets, LTDA is long-term debt to total assets and TLTA is total liabilities to total assets. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. The results are estimated by system GMM. The table reports the *J statistic* from a test of the over identifying restrictions, and the *J statistic* is asymptotically distributed as chi-squared under the null of instrument validity, and the test of second-order autocorrelation (*m2*) in the first differenced residuals. Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	TDA			NDA			LTDA			TLDA		
Variables	NIN	INN	Diff (p-value)	NIN	INN	Diff (p-value)	NIN	INN	Diff (p-value)	NIN	INN	Diff (p-value)
Lev_{it-1}	0.842***	0.706***	(0.036)	0.698***	0.514***	(0.042)	0.762***	0.621***	(0.063)	0.734***	0.790***	(0.450)
	(0.055)	(0.039)		(0.074)	(0.052)		(0.061)	(0.044)		(0.056)	(0.058)	
R&D		-0.144***	(0.000)		-0.216***	(0.000)		-0.057**	(0.011)		-0.204***	(0.000)
		(0.038)			-0.057			-0.022			-0.052	
Capex	0.158***	0.038	(0.100)	0.200**	0.071	(0.222)	0.042	0.043	(0.989)	0.142***	-0.044	(0.027)
	(0.053)	(0.054)		(0.080)	(0.070)		(0.064)	(0.040)		(0.055)	(0.067)	
Tangible	0.021	0.093***	(0.002)	0.112***	0.364***	(0.000)	0.045***	0.086***	(0.051)	-0.050**	0.021	(0.019)
	(0.016)	(0.019)		(0.029)	(0.048)		(0.015)	(0.016)		(0.021)	(0.025)	
Intangible	0.010	0.075***	(0.002)	0.140***	0.322***	(0.000)	0.041**	0.086***	(0.047)	-0.030	-0.011	(0.451)
	(0.018)	(0.016)		(0.032)	(0.039)		(0.018)	(0.016)		(0.019)	(0.021)	
Growth	-0.005	0.000	(0.221)	-0.012*	-0.003	(0.234)	-0.002	0.000	(0.708)	0.020***	0.004	(0.020)
	(0.004)	(0.002)		(0.007)	(0.003)		(0.005)	(0.001)		(0.006)	(0.003)	
Size	0.005***	0.005***	(0.700)	0.007***	0.000	(0.000)	0.006***	0.006***	(0.930)	0.010***	0.008***	(0.588)
	(0.001)	(0.001)		(0.002)	(0.002)		(0.001)	(0.001)		(0.002)	(0.002)	
Profit	-0.207***	-0.166***	(0.222)	-0.255***	-0.153***	(0.025)	-0.075***	-0.079***	(0.866)	-0.339***	-0.285***	(0.220)
	(0.026)	(0.021)		(0.038)	(0.026)		(0.019)	(0.012)		(0.030)	(0.034)	
NDTS	-0.121	-0.202**	(0.522)	-0.045	-0.239**	(0.276)	-0.028	-0.107	(0.525)	0.336**	0.209	(0.525)
	(0.100)	(0.086)		(0.139)	(0.119)		(0.101)	(0.081)		(0.142)	(0.139)	
Volatility	-0.066	(0.037)	(0.636)	-0.170**	-0.205***	(0.694)	-0.012	-0.020	(0.868)	-0.071	-0.193***	(0.071)
	(0.048)	(0.042)		(0.081)	(0.035)		(0.041)	(0.023)		(0.056)	(0.042)	
Constant	-0.032**			-0.087**			-0.085***			0.007		
	(0.017)			(0.034)			(0.017)			(0.021)		
N	5457			5457			5457			5457		
m2	-0.228			-1.252			-0.307			-0.408		
p-value	(0.820)			(0.210)			(0.759)			(0.683)		
J	147.698			148.250			153.455			144.249		
p-value	(0.312)			(0.300)			(0.206)			(0.385)		

Chapter 5

Leverage Adjustments: The Case of Innovative versus Non-Innovative Firms

5.1 Summary

The literature on the factors that affect target financing behaviour relate to one of the most important issues in corporate finance. Yet, little is known about how corporate investments affect the speed of adjustment and the time variations in leverage adjustment, with the literature having largely focused on quantifying the speed of adjustment. This chapter investigates the differences in leverage adjustments between innovative firms and non-innovative firms in the UK over the period 1987-2013. The chapter reports evidence of asymmetry and time variations in leverage adjustment between and within firms that report R&D and those that do not report R&D. A comparison of the speed of leverage adjustment in both the cross-section and over time, between innovative and non-innovative firms, reveals that innovative firms consistently have a relatively higher speed of adjustment. This result suggests that the benefits of adjusting towards the target are higher for firms that are likely to face binding financial distress costs. Overall, the analysis reveals that heterogeneity in corporate investments is an important factor to the understanding of asymmetry in target financing behaviour.

5.2 Introduction

Despite advancements in the literature, a number of questions on how managers decide on capital structure remain unresolved. Do firms have a target capital structure? If they do, what is the speed of adjustment towards this target? Further, is this speed constant or does it change over time? According to Huang and Ritter (2009), questions on target financing behaviour are among the most important issues in capital structure research. However, Iliev and Welch (2010) have challenged this assertion arguing that it tends to overstate the importance of target financing behaviour as other competing theories (market timing or pecking order theory) do not predict the existence of a target capital structure. Similarly, Myers (1984) highlights that if firms take extended excursions away from their targets, then researchers should focus on examining the factors that cause the excursions. The importance attached to the estimation of the speed of adjustment as evidenced by the growing literature arises from its usefulness in sorting competing theories on capital structure. The literature has evolved from merely establishing the existence of a target leverage to the actual quantification of the speed of adjustment. This growth shows the importance that researchers place in understanding the factors that may impede firms from adjusting towards the optimal capital structure as predicted by the trade-off theory (e.g., Elsas and Florysiak, 2011; Faulkender et al., 2012; Lemmon et al., 2008; Koufopoulos and Lambrinoudakis, 2013).

The trade-off theory postulates that firms have a target capital structure that arises as a result of balancing the tax shield and financial distress costs associated with debt financing. A significant estimate of the speed of adjustment supports the existence of a target as predicted by the trade-off theory. In the absence of adjustment costs, firms fully adjust towards the target.[1] However, the existence of adjustment costs impede the attainment of the target.[2] The two other major competing theories on capital structure are premised on opposing predictions to the trade-off theory. The pecking order theory postulates that the existence of information asymmetry results in distinctive ordering of preferences for different financing sources (internal and external) (see, Myers, 1984; Myers and Majluf, 1984). Following the predictions of the pecking order theory, retained earnings are preferred to debt and equity, while debt is preferred to equity, and equity is only used as a last resort when all other sources have been exhausted. The market timing theory is based on the proposition that managers strategically time the issue (repurchase) of securities to coincide with favourable (unfavourable) market conditions (Baker and Wurgler, 2002; Heaton, 2002). The observed capital structure under the market timing theory is a result of cumulative efforts by managers to exploit the perceived mispricing of securities rather than an attempt to re-balance capital structure towards a target. According to

[1] For a review of the dynamic trade-off theory, see Fischer et al. (1989), Goldstein et al. (2001), Hennessy and Whited (2005) and Strebulaev (2007).

[2] The nature of the adjustment costs have implications on the form of the leverage adjustments. According to Leary and Roberts (2005), fixed adjustment costs generate infrequent but large adjustments, while proportional adjustment costs generate small but more frequent leverage adjustments. Adjustment costs are made up of implicit costs of deviating from target and explicit costs such security issuance costs.

Frank and Goyal (2009), attempts at developing a unified theory on capital structure appear to be fruitful avenues for future research, but the daunting task of reconciling the often competing theories (trade-off, marketing and pecking order theory) is the major impediment.

The rather mixed empirical evidence on target financing behaviour, even within the US market, in which the majority of studies on capital structure are concentrated, show that much is yet to be resolved about capital structure. For example, Dang et al. (2014a) (31% - 33%), Flannery and Rangan (2006) (34% - 36%), Huang and Ritter (2009) (17% - 23%), Lemmon et al. (2008) (25%) and Lockhart (2014) (50% - 77%) report moderate to high speeds of adjustment. A slow speed of adjustment is inconsistent with the trade-off theory which postulates that firms have a target leverage (see, Lemmon et al., 2008; Huang and Ritter, 2009). Contrary to studies that report moderate to high speed of adjustment, Fama and French (2002) and Kayhan and Titman (2007) report that US firms adjust leverage at a relatively slow rate of 7% - 18% and 8.3% - 10%, respectively. Similarly, Welch (2004) and Iliev and Welch (2010) report limited or no evidence supporting active leverage adjustments in the US over the periods 1962–2000 and 1963–2007, respectively. Chang and Dasgupta (2009) and Chen and Zhao (2007) also cast doubts on evidence supporting target financing behaviour in separate studies in the US over the periods 1971-2004 and 1971-2002, respectively. The wide variations in the estimates of the speed of adjustment from previous studies, reported in Appendix 5.A, highlight that questions on target financing behaviour remain open to debate, especially for other economies with institutional and macroeconomic frameworks different from those of the US.[3]

To add to discourse in the literature, a survey of Chief Finance Officers (CFOs) in the US by Graham and Harvey (2001) highlights wider discrepancies between prescribed theoretical predictions and practice. In particular, Graham and Harvey (2001) report that managers in the survey follow theory in capital budgeting (by evaluating new

[3] It is important to note that Antoniou et al. (2008) and Oztekin and Flannery (2012) report that differences in the legal and institutional environments between the US and the UK explain some of the observed variations in capital structure between the two economies.

investment projects using discounted cash flow (DCFs) and net present value (NPV) techniques), but often resort to rules of thumb on capital structure by seeking to preserve financial flexibility instead of minimising weighted average cost of capital (WACC). Buera and Kaboski (2012) also highlight that the literature has overlooked the effects of the significant transition of economies from predominantly manufacturing sectors towards technological and service based sectors on corporate decisions. Similarly, Borisova and Brown (2013) report marked increases over the period 1980-2008 in R&D in young US firms to levels that are four times that of capital expenditure, while R&D is twice as high as capital expenditure for mature firms. Fama and French (2004, 2005) also report an influx of new listings in the US by young and high growth firms from 1980 to 2001. Consistent with the results in the US, Figure 3.2 in Chapter 3 shows similar marked increases in R&D in the UK over the period 1987 to 2013. However, the effects of these changes in the composition of firms on corporate financing decisions, in particular, on leverage adjustments, has largely been overlooked. Borisova and Brown (2013) highlight that studies on intangible investments, such as R&D, are rather limited with the literature having largely focused on capital expenditure. Similarly, Buera and Kaboski (2012) highlight that studies in corporate finance that only focus on changes within firms have overlooked the important effects of changes in the composition of firms on the dynamics in cash holdings.

What are the effects of the increase in innovative investments on capital structure decisions? This question remains unanswered as debt financing is largely persistent, and has been increasing over time. Graham et al. (2015) report a threefold increase in corporate debt financing by non-financial firms in the US over the past century. Similarly, DeAngelo and Roll (2015) report a wholesale abandonment of conservative financing policies in the US after the Second World War as economies started to recover. Breitkopf and Elsas (2012) highlight that firms in the US are systematically over-levered as their estimated loss-given-default are higher than that implied by the current debt tax shield.[4] The rising corporate debt levels is an empirical irregular-

[4]Studies in the US also report evidence of a marked increase in corporate gearing over the period leading to the recent global financial crisis (e.g., Almeida et al., 2012; Campello et al., 2010, 2011a,b; Carmassi et al., 2009; Chava and Purnanandam, 2011; Dang et al., 2014a; Kahle and Stulz, 2013;

ity that poses important questions on how changes in corporate investments impact on capital structure. Furthermore, questions on how managers decide on capital structure (Myers, 2003) and whether capital structure affects real decisions such as investment decisions (Lang et al., 1996) or firm value (Korteweg, 2010; Van Binsbergen et al., 2010) still remain largely unresolved despite decades of extensive research. If leverage has not subsided, does this imply that intangible investments are increasingly being financed with debt?

Against this background, this chapter revisits questions on capital structure by investigating whether corporate investments cause heterogeneity in leverage adjustments.[5] This research is motivated by the lack of empirical evidence on how investment affect target financing behaviour, yet, there has been secular changes in corporate investments, in particular, a marked increase in R&D in the US (see, Begenau and Palazzo, 2015; Brown and Petersen, 2009; Hall and Lerner, 2010).[6] These changes in corporate investments have empirically testable implications on target financing behaviour:[7] (i) the increase in operating risk of firms arising from innovative investments should prompt firms to adopt conservative financing structures;[8] (ii) since the costs of deviating from the target should increase with financial distress costs, the increase in innovative investments should result in an increase in the speed

Miglo, 2013).

[5]The linkages between financing activities and real decisions (e.g., investment) in the presence of market imperfection remain largely ambiguous (see, Chava and Roberts, 2008; Stein, 2003). Empirical studies on the linkages between finance and investment report mixed results, with one strand of the literature reporting significant or insignificant linkages (e.g., Mauer and Triantis, 1994), while the other, either reports a positive (e.g., Lyandres and Zhdanov, 2005; Rashid and Caglayan, 2012) or a negative relationship (e.g., Aivazian et al., 2005; Dang, 2011; DeAngelo and Masulis, 1980; Lang et al., 1996).

[6]Recently, Krainer (2014) reports that events from the recent global financial crisis in the US have highlighted the importance of the overlooked interaction between the financial and the real side of an economy (private and public investments). Similarly, DeAngelo and Roll (2015) highlight the need to devote more effort to investigate the effect of other factors such as investment, pay-out, and capital market access in light of the failure of traditional factors to explain much of the observed cross-sectional or time variations in capital structure.

[7]Appendix 5.B shows a marked increase in intangible assets and decrease in tangible assets over the period 1983-2013.

[8]Innovative investments are associated with high information asymmetry, asset substitution, longer investment horizons, and low pledgeable value issues is likely to subject firms to binding financial constraints (e.g., Borisova and Brown, 2013; Brown and Petersen, 2011; Brown et al., 2012; Moshirian et al., 2013). The ever increasing dominance of innovative investments, which have more than doubled over the past decades, should lead to the adoption of more conservative capital structures as firms also use capital structure to strategically manage or counteract risks (Dierker et al., 2013) or earnings volatility (Dang et al., 2014a).

of adjustment; (iii) as firms use capital structure to respond to changes in operating risk, innovative firms should show wider variability in the speed of adjustment than non-innovative firms with lower operating risk.

To conduct the analysis on the heterogeneity in leverage adjustment arising from differences in corporate investments, this chapter uses a series of dynamic panel data models estimated on a sample of 817 firms in the UK over the period 1987-2013. First, the sample is sub-divided into two groups: innovative firms, which report R&D, and non-innovative firms that do not report R&D. This sub-division allows for comparisons of target financing behaviour to be drawn between innovative and non-innovative firms. Second, the target is estimated based on firm characteristics identified in the literature to be the most reliable determinants of capital structure.[9] Third, the estimates of the target capital structure are then used to investigate any differences in the speed of adjustment between innovative and non-innovative firms. Fourth, interaction terms between the deviation from target and the financing deficit are introduced to investigate the effects of financing deficits on target financing behaviour. Finally, the analysis examines time variation in the speed of adjustment by estimating dynamic panel models separately for innovative and non-innovative firms over a 5-year rolling window.

The main empirical findings of the analysis in this chapter are as follows. Although collateral has fallen and innovative investments have increased considerably, leverage has remained largely persistent, with a slight upward drift that is characterised by temporary spikes. Over the period 1987-2013, firms in the UK increasingly shifted towards long-term debt, and the proportion of short-term debt on corporate balances became progressively smaller. The persistence and upward drift of leverage is rather inconsistent with predictions that firms should de-lever to reduce the operating risk arising from increases in innovative investments. According to Hall (2002), innovative investments should, therefore, be mostly financed with equity since the use of

[9]See Frank and Goyal (2009) and Oztekin (2015) for a review of the most reliable determinants of capital structure.

debt often entails restrictive covenants which reduce strategic flexibility. The time trend in leverage is largely similar across firms undertaking different forms of investment, with non-innovative firms (firms that do not report R&D) being more levered than comparable innovative firms (firms that report R&D) only during the period 2000-2013. The similar trends in leverage of innovative and non-innovative firms are inconsistent with the results reported from studies that use US data, which show that firms with R&D use less debt (e.g., Fama and French, 2002; Buera and Kaboski, 2012; Hall, 2009). The low debt for firms that report R&D in the US could result from the desire to preserve financial flexibility (through maintaining financial slack), which is valuable due to the presence of investment options.[10]

The estimated average speed of adjustment from the analysis in this chapter is 34.9% for the period 1987-2013. This result indicates that non-financial firms in the UK take on average 3.23 years (or half-life of 1.61 years) to adjust leverage towards the target.[11] The moderate speed of adjustment of 34.9% supports the presence of adjustment costs which impede firms from fully adjusting towards the target. This result coincides with evidence from the US, and suggests that firms in the UK have a target capital structure as predicted by the trade-off theory.[12] However, this speed of adjustment is higher than that reported in the US studies by Fama and French (2002) (7% - 18%) and Kayhan and Titman (2007) (8.3% - 10%), and is inconsistent with Welch (2004) who reports limited or no adjustment at all in the US.[13] The results from the analysis in this chapter also show that modelling asymmetry in financing decisions is important in the understanding of the heterogeneity in target financing as firms with above-target leverage (44.2%) consistently have higher speed of adjustment than firms with below-target leverage (27.8%). The relatively higher speed of

[10]According to O'Brien (2003), firms in highly competitive product markets in the US such as that of information technology seek to maintain strategic flexibility.

[11]Using half-life convention, the time taken to adjust half of the deviation from target is calculated as $ln(0.5)/ln(1-\lambda)$, where λ is the estimated speed of adjustment.

[12]Prior US studies report ranges of the speed of adjustment between 0% and 40% (see, Dang et al., 2014a; Flannery and Rangan, 2006; Huang and Ritter, 2009; Lemmon et al., 2008). Similarly, Faulkender et al. (2012), Leary and Roberts (2005) and Strebulaev (2007) report that adjustment costs are the major impediments to the attainment of the the target and that firms will only adjust towards the target if the benefits outweigh the associated costs.

[13]Appendix 5.A presents a summary of the results of studies on target financing behaviour on the US and other countries.

adjustment for firms with above-target leverage is consistent with the proposition that bankruptcy costs increase with debt, therefore, over-levered firms benefit relatively more than under-levered firms from adjusting leverage towards the target.

Comparisons of the speed of adjustment between innovative and non-innovative firms suggests that accounting for the types of investment that firms engage in, is important in understanding the heterogeneity in target financing behaviour. The seemingly contradictory trends on leverage carry over to target financing behaviour as innovative firms consistently have a higher speed of adjustment than non-innovative firms. The speed of adjustment for innovative firms is 44.8%, which implies that these firms take on average 2.34 years (or a half-life of 1.17 years) to revert to the target leverage, whereas non-innovative firms have a speed of adjustment of 28.3%, which implies that these firms take 4.16 years (or a half-life of 2.08 years) to revert to the target leverage. The difference becomes even more pronounced when asymmetry in leverage adjustment is considered, as over-levered innovative (non-innovative) firms have a speed of adjustment of 51.9% (34.9%) while under-levered innovative (non-innovative) firms have a speed of adjustment of 37.5% (24.1%). This implies that innovative firms with above-target and below-target leverage adjust at a rate of one and half times as fast in comparison to non-innovative firms. The relatively high speed for innovative firms suggests that the costs of deviating from the target are relatively higher for firms facing potential financing distress costs, which motivates them to more actively re-balance capital structure. This finding is new to the literature as it shows that asymmetries arising from corporate investments are a significant factor in understanding heterogeneity in target financing behaviour. The differences in the speed of adjustment due to differences in the type of investment remain significant even after controlling for other factors affecting capital structure and the position (above or below-target) of the firm relative to the target.

An investigation of the variability of leverage adjustment over time reveals that non-innovative and innovative firms consistently adopt diverging target financing behaviour.[14] Throughout the period 1987-2013, the consistently higher speed of adjustment of innovative firms exhibits more variability than that of non-innovative firms. Further, there seems to be three periods of distinctive patterns in the time variation in the speed of adjustment. Over the period 1987-2001, innovative and non-innovative firms have different target financing behaviour as the speed of adjustment increases for innovative firms but decreases for non-innovative firms. In contrast, the period 2001-2006 is marked by a pronounced decrease in the rate at which innovative firms adjust leverage, with a slight increase for non-innovative firms. From 2006 to 2010, all firms report an increase in the speed of adjustment, but the increase is more pronounced for innovative firms. The period beyond 2009 is marked by fluctuations in the speed of adjustment. This result suggests that firms facing high bankruptcy costs counteract the higher costs associated with using more debt financing by actively adjusting faster towards the target rather than by just adopting an overly conservative financing structure.[15] Overall, the asymmetry in the speed of adjustment suggests that it is important to model heterogeneity arising from differences in corporate investments so as to gain a better understanding of financing decisions of firms that engage in target financing behaviour.

The analysis presented in this chapter relates to Aghion et al. (2004) who report that the probability of equity issuance in the UK increases with R&D, and that there is a negative non-linear effect of R&D on leverage. However, this study differs from Aghion et al. (2004) in that it investigates target financing behaviour and how the speed of adjustment differs between innovative and non-innovative firms, rather than focusing on how R&D affects the probability of issuing or repurchasing/retiring equity and debt. Adjustment costs should differ between innovative and non-innovative

[14] Time variations have largely been overlooked with a few US studies that have investigated heterogeneity focusing on cross-sectional variations capital structure (e.g., Byoun, 2008; Flannery and Lockhart, 2009; Hovakimian et al., 2009; Lockhart, 2014; Warr et al., 2012). By analysing both cross-sectional and time-varying heterogeneity in leverage adjustment, this chapter offers a more comprehensive analysis with new insights on the mixed results in the literature and UK where studies are rather limited.

[15] Krainer (2014) develops a model that show that managers make investment decisions commensurate with the risk tolerance of the investors and use capital structure to offset any deviations from the acceptable risk thresholds. This chapter provides empirical evidence consistent with the theoretical predictions of the model as managers of innovative firms (whose investments are risky) adjust leverage faster than those of non-innovative firms.

firms, with the former benefiting more than the latter as they face higher financial distress costs. This study also relates to the growing literature on R&D (e.g., Acemoglu et al., 2010; Borisova and Brown, 2013; Brown et al., 2012; Hall and Lerner, 2010; Moshirian et al., 2013). The chapter builds on this literature by showing that the effects of innovative investments are not significant only on the debt-equity choice but extends to several aspects of capital structure, in particular, target financing behaviour. The significant differences in the speed of adjustment that this chapter reports show that the type of investment undertaken by firms has significant effects on leverage adjustments.

This chapter complements prior effort on target financing behaviour by providing additional empirical insights on asymmetry in leverage adjustments due to differences in the forms of investment.[16] Most studies are premised on the proposition of homogeneous leverage adjustments with only a few notable exceptions (e.g., Byoun, 2008; Dang et al., 2014a; Elsas and Florysiak, 2011; Faulkender et al., 2008; Hovakimian and Li, 2010; Lockhart, 2014). For example, Byoun (2008) was among the first group of studies in the US to show that the speed of adjustment varies with leverage and financing surplus or deficit. In addition to showing that the speed of adjustment is significantly higher for firms with above-target leverage than firms with below-target leverage as reported by Byoun (2008), the results from the analyses in this chapter further show that the difference increases when modelling heterogeneity in corporate investment. The results in this chapter also show that heterogeneity in corporate investment has a significant effect on target financing behaviour as innovative firms adjust leverage one and half times faster than non-innovative firms whether they are below or above-target. Dang et al. (2014a) report moderate evidence of cross-sectional differences in the speed of adjustment in the US around the global financial crisis based on growth, large investment, size, and earnings volatility. Similarly, Elsas and Florysiak (2011) report significant heterogeneity in the speed of adjustment based on industrial classifications, size, growth, leverage and default risk. This chap-

[16]The literature on target financing behaviour has been growing over time (see, Byoun, 2008; Chang and Dasgupta, 2009; Dang et al., 2014a; Elsas and Florysiak, 2011; Faulkender et al., 2008; Harford et al., 2009; Koufopoulos and Lambrinoudakis, 2013).

ter presents evidence that leverage adjustments are significantly non-homogeneous due to differences in initial deviation from target, and most importantly, differences in corporate investments even after controlling for the factors identified by Dang et al. (2014a) and Elsas and Florysiak (2011). The heterogeneity in corporate investments and how it affects corporate decisions, in particular capital structure, remain largely ambiguous and has been overlooked in the literature (see, Chava and Roberts, 2008; Stein, 2003).

In addition to focusing on cross-sectional heterogeneity, this chapter also investigates time variations in leverage adjustments. Time variations are informative on changes in firm characteristics and the underlying macroeconomic conditions (e.g., Cook and Tang, 2010; Hackbarth et al., 2006). Cook and Tang (2010) report evidence that firms adjust faster (slower) in good (bad) macroeconomic environments. The evidence presented in this chapter suggests that much of the adjustments are done by innovative firms rather than non-innovative firms. Innovative firms are more active in re-balancing capital structure as the costs of deviating form target are relatively higher than for non-innovative firms. This chapter also relates to recent US studies on the effects of large (lumpy) investments on capital structure (e.g., Dudley, 2012; Elsas et al., 2013; Whited, 2006). Although Dudley (2012) reports that the speed of adjustment increases with size of investment projects, they do not examine how heterogeneity in corporate investment (innovative and non-innovative investments) affect target financing behaviour.[17] This study adds new insights on how different forms of investment drive heterogeneity in capital structure through an explicit comparison between innovative and non-innovative firms.

The rest of this chapter is organised as follows: Section 5.3 presents the methodology, Section 5.4 discusses the the empirical results, Section 5.5 presents several robustness tests, and Section 5.6 concludes and suggests areas for further research.

[17] Brown et al. (2012) highlight that prior studies have often treated the capital expenditure and R&D similarly, overlooking the differences in their risk characteristics. They show that firms use cash reserves to smoothen R&D expenditure and mostly equity if external financing is required.

5.3 Methodology

In line with the literature, this analysis proceeds by estimating the speed of adjustment using dynamic panel data models in a two-step procedure.[18] The first step estimates target leverage in two ways. The average target leverage for all firms is estimated with the following equation:

$$L_{it} = \gamma L_{it-1} + \boldsymbol{\theta}\mathbf{X}_{it-1} + \eta_i + \eta_t + \xi_{it} \tag{5.1}$$

where L_{it} is the leverage for firm i at time t, γ is the first order autocorrelation of leverage ($1-\gamma$ is the speed of adjustment), $\boldsymbol{\theta}$ is a vector of coefficient sensitivities to the set of firm-specific characteristic variables $\mathbf{X}_{it-1}$, η_i are unobservable firm specific effects, η_t are time-specific effects and ξ_{it} is an error term.[19] The average target leverage for all firms is then defined as $L^*_{it} = \hat{\boldsymbol{\theta}}\mathbf{X}_{\boldsymbol{it-1}}$. The implied speed of adjustment for all firms is computed as $1-\gamma$.

In all other cases when innovative firms are differentiated from non-innovative firms, the following version of Equation (5.1) is used to estimate target leverage:

$$L_{it} = \gamma_1 L^{INN}_{it-1} + \gamma_2 L^{NIN}_{it-1} + \boldsymbol{\theta}^{NIN}\mathbf{X}^{NIN}_{it-1} + \boldsymbol{\theta}^{INN}\mathbf{X}^{INN}_{it-1} + \zeta_i + \zeta_t + \mu_{it} \tag{5.2}$$

where, γ_1 and γ_2 are the first order autocorrelations for innovative firms and non-innovative firms, respectively; $\boldsymbol{\theta}^{INN}$ and $\boldsymbol{\theta}^{NIN}$ are the sensitivities to firm-specific characteristics of innovative and non-innovative firms, respectively; ζ_i are firm-specific effects; ζ_t are time-specific effects; and μ_{it} is the error term. The target leverage for innovative firms is computed as $\boldsymbol{\theta}^{INN}\mathbf{X}^{INN}_{it-1}$, and that for non-innovative firms as $\boldsymbol{\theta}^{NIN}\mathbf{X}^{NIN}_{it-1}$. These are then stacked as the overall firm estimate for target leverage L^*_{it}. The focus of Equation (5.2) is on whether the coefficients differ between non-innovative (NIN) and innovative (INN) firms.

[18] Dynamic panel data models are used by Dang et al. (2012), Dang et al. (2014a), Faulkender et al. (2012), Lemmon et al. (2008), and Oztekin (2015) to estimate the speed of adjustment.

[19] The vector of lagged firm specific determinants of leverage, $\mathbf{X}_{it-1}$, includes R&D, capital expenditure (Capex), tangible assets, intangible assets, growth, size, profit, non-debt tax shield (NDTS) and volatility.

The target leverage (L_{it}^*) computed above is used in the second step to estimate the speed of adjustment as follows:

$$\Delta L_{it} = L_{it} - L_{it-1} = \lambda(L_{it}^* - L_{it-1}) + \varepsilon_{it} \tag{5.3}$$

where ΔL_{it}, is the change in leverage from the previous year, λ is the measure of the speed of adjustment and ε_{it} is an error term. If $\lambda = 0$, then there is no adjustment; $\lambda = 1$ then there is full adjustment towards the target; and if $0 < \lambda < 1$, then there is partial adjustment, with the last being consistent with the existence of adjustment costs.

To investigate the differences in the speed of adjustment between innovative and non-innovative firms, Equation (5.3) is modified to include a dummy variable (*RDD*) that takes the value of one for firms that report R&D and zero otherwise:

$$\Delta L_{it} = (\lambda_1 + \lambda_2 \times RDD) Dev_{it} + \varepsilon_{it} \tag{5.4}$$

where λ_1 is the measure of the speed of adjustment for all firms, λ_2 is the measure of the difference in the speed of adjustment between non-innovative (NIN) and innovative firms (INN) and $Dev_{it} = L_{it}^* - L_{it-1}$, is the deviation from target leverage.

Equations (5.1) – (5.3) are premised on the assumption that firms adopt homogeneous target financing behaviour. However, Dang et al. (2012), Flannery and Hankins (2013) and Huang and Ritter (2009) highlight that this assumption is rather restrictive, as it fails to consider the asymmetry that characterises corporate financing behaviour. It is more reasonable and tractable to expect that over-leveraged and under-leveraged firms may follow different target financing behaviour due to differences in adjustment costs or benefits of using leverage. There are only a few studies that have considered the asymmetry in target financing behaviour explicitly (e.g., Byoun, 2008; Faulkender and Wang, 2006; Faulkender et al., 2012; Shyam-Sunder and Myers, 1999). According to Byoun (2008) firms adjust leverage at a faster rate when they have a financial deficit with below-target leverage or a financial surplus with above-target leverage than when they have a financial surplus with below-target leverage or a financial deficit with above-target leverage. Such asymmetries cannot be examined by models that assume homogeneous target financing behaviour.

In order to examine asymmetry in leverage adjustments, a modified version of Equation (5.3) conditional on the initial deviation from the target is specified as follows:

$$\Delta L_{it} = \lambda_1^{Above} Dev_{it}^{Above} + \lambda_2^{Below} Dev_{it}^{Below} + \varepsilon_{it} \tag{5.5}$$

where λ_1^{Above} is the speed of adjustment for firms with above-target leverage, λ_2^{Below} is the speed of adjustment for firms with below-target leverage, Dev_{it}^{Above} is deviation from target leverage for firms with leverage above the target, and Dev_{it}^{Below} is deviation from target leverage for firms with leverage below the target. If adjustment is symmetric as in Equation (5.1), then $\lambda_1^{Above} = \lambda_2^{Below}$, and firms above or below the target adjust at the same rates. However, differences in firm characteristics and operating environments may result in asymmetries in target financing behaviour.

Further, Equation (5.5) is extended to investigate the differences between innovative and non-innovative firms with above and below-target leverage as follows:

$$\Delta L_{it} = (\lambda_1^a + \lambda_2^b \times RDD) Dev_{it}^{Above} + (\lambda_3^c + \lambda_4^d \times RDD) Dev_{it}^{Below} + \varepsilon_{it} \tag{5.6}$$

where λ_1^a is the speed of adjustment for all firms with above-target leverage, λ_2^b is a measure of the difference in the speed of adjustment between non-innovative and innovative firms with above-target leverage, λ_3^c is the speed of adjustment for all firms with below-target leverage and λ_4^d is a measure of the difference in the speed of adjustment between non-innovative and innovative firms with below-target leverage. If adjustment is asymmetric but with no differences between non-innovative and innovative firms, then λ_2^b and λ_4^d should be insignificant.

In further analyses of the effects of financing deficits on target financing behaviour, Equation (5.4) is modified to include a dummy variable, FD_{it}, that takes the value of one if a firm has a financing deficit and zero otherwise:

$$\Delta L_{it} = (\lambda_{11} + \lambda_{21} \times FD_{it})Dev_{it} + \varepsilon_{it} \tag{5.7}$$

where λ_{11} is the measure of the speed of adjustment for all firms and λ_{21} is the measure of the difference in the speed of adjustment between firms with a financing deficit and firms that do not have a financing deficit.

Equation (5.7) is extended to investigate the differences between non-innovative and innovative firms with a financing deficit (FD_{it}) as follows:

$$\Delta L_{it} = (\lambda_{12} + \lambda_{22} \times FD_{it} + \lambda_{32} \times FD_{it} \times RDD)Dev_{it} + \varepsilon_{it} \tag{5.8}$$

where λ_{12} is the measure of the speed of adjustment for all firms, λ_{22} is the measure of the difference in the speed of adjustment between all firms with a financing deficit and all firms that do not have a financing deficit and λ_{32} is the measure of the difference in the speed of adjustment between innovative firms with a financing deficit and non-innovative firms that have a financing deficit.

In order to investigate the effects of a financing deficit on firms with above and below-target leverage, Equation (5.5) is augmented with a dummy variable that is used to examine the effects of financing deficits (FD_{it}) on leverage adjustments as follows:

$$\Delta L_{it} = (\lambda_{13} + \lambda_{23} \times FD_{it})Dev_{it}^{Above} + (\lambda_{33} + \lambda_{43} \times FD_{it})Dev_{it}^{Below} + \varepsilon_{it} \tag{5.9}$$

where λ_{13} is the speed of adjustment for all firms with above-target leverage, λ_{23} is the measure of the difference in the speed of adjustment for all firms with above-target leverage and a financing deficit, and all firms with above-target leverage but do not have a financing deficit, λ_{33} is the speed of adjustment for all firms with below-target leverage, λ_{43} is the measure of the difference in the speed of adjustment for firms all with below-target leverage and a financing deficit, and all firms with below-target leverage but do not have a financing deficit.

Finally, Equation (5.9) is extended to investigate the effects of both the financing deficit on leverage adjustments and the differences in leverage adjustments between non-innovative and innovative firms as follows:

$$\begin{aligned} \Delta L_{it} &= (\lambda_{14} + \lambda_{24} \times FD_{it} + \lambda_{34} \times FD_{it} \times RDD)Dev_{it}^{Above} \\ &+ (\lambda_{44} + \lambda_{54} \times FD_{it} + \lambda_{64} \times FD_{it} \times RDD)Dev_{it}^{Below} + \varepsilon_{it} \end{aligned} \tag{5.10}$$

where L_{it} is the leverage for firm i at time t, λ_{14} is the speed of adjustment for firms with above-target leverage, λ_{24} is the measure of the difference in the speed of adjustment for firms with above-target leverage and a financing deficit, and firms with above-target leverage but do not have a financing deficit, λ_{34} is the measure of the difference in the speed of adjustment for innovative firms with above-target leverage, and a financing deficit, and all firms with above-target leverage but do not have a financing deficit, Dev_{it}^{Above} is deviation from target leverage for firms with leverage above the target, λ_{44} is the speed of adjustment for all firms with below-target leverage, λ_{54} is the measure of the difference in the speed of adjustment for all firms with below-target leverage and a financing deficit, and all firms with below-target leverage but do not have a financing deficit, λ_{64} is the measure of the difference in the speed of adjustment for innovative firms with below-target leverage, and a financing deficit, and all firms with below-target leverage but do not have a financing deficit, Dev_{it}^{Below} is the deviation from target leverage for firms with leverage below the target.

There are two alternative methods used for estimating the speed of adjustment (λ). The first is a one-step approach that involves the joint estimation of the target leverage (L_{it}^{*}) and the implied speed of adjustment $(1-\gamma)$ in Equations (5.1) and (5.2) by system Generalised Method of Moments (system GMM thereon). The second approach adopted in the estimation of Equations (5.3)–(5.10) involves a two-step procedure, where in the first step, the target leverage is estimated by system GMM based on firm specific factors.[20,21] The second step involves substituting the estimated target leverage into Equation (5.3) to estimate the speed of adjustment. Byoun (2008), Fama and French (2002) and Faulkender et al. (2012) use a similar two-step procedure to estimate the speed of adjustment. Although the one-step approach is more efficient, the two-step procedure is preferred as it allows for modelling of asymmetries in leverage adjustments (see, Dang et al., 2014a; Flannery and Rangan, 2006; Ozkan, 2001). Using the one-step approach to model asymmetries in leverage adjustment does not allow for direct testing of differences in the speed of adjustment as this would involve comparing estimates of the speed of adjustment across two models estimated separately. The two-step procedure allows for direct tests of the differences in the speed of adjustment. Having said that, the estimation results using the one-step approach are also presented for robustness and for comparisons with prior studies that use a similar approach. The inclusion of investment structure variables in the estimation of the target leverage is aimed at testing whether differences in corporate investments cause heterogeneous leverage adjustments.

Equations (5.1) and (5.2) are estimated by system GMM.[22] Using simulations, Flannery and Hankins (2013) conclude that the system GMM developed by Blundell and Bond (1998) generally provides more consistent estimates than other methods used

[20]The target leverage, L^*_{it}, is estimated including firm fixed effects as is consistent with recent studies that report significant variations in target leverage attributable to firm fixed effects (e.g., Byoun, 2008; Flannery and Rangan, 2006; Lemmon et al., 2008). An estimate of the time-invariant firm-fixed effects is obtained by estimating Equations (5.1) and (5.2) using system GMM. The predicted residuals are then regressed on panel indicator variables. The fitted values from the second regression of the residuals on the panel indicator variables are then used as estimates for the firm fixed effects.

[21]The estimated target leverage is restricted to be within the unit interval as some estimates may inevitably lie outside this interval (e.g., Byoun, 2008; Dang et al., 2012; Faulkender et al., 2012; Hovakimian, 2004; Hovakimian and Vulanovic, 2010).

[22]The system GMM estimator is implemented using xtabond2 in Stata (Roodman, 2006). The instruments used in this study are restricted to the second and third lags to address the problem of having excessive instruments. Dynamic panel data estimators (DPD) such as the system GMM used in this chapter are prone to problems of excessive instruments that proliferates as the sample size increases (see, Vincent and Michaely, 2012). Roodman (2009) proposed two ways of addressing the problem of excessive instruments. This involves either curtailing the instrument count by restricting the number of lags used in each estimation or "collapsing" the instrument set, all of which will make the instrument count linear in T. According to Mehrhoff (2009), restricting the the number of lags used and "collapsing" the instrument set at the same time makes the instrument count invariant to T.

in the estimation of dynamic panel models in corporate finance.[23] The system GMM increases efficiency by combining equations estimated in levels with those in differences, and also controls for potential endogeneity problems as it allows the use of first differenced and lagged level variables as instruments. According to Flannery and Hankins (2013), endogeneity problems may arise due to simultaneity, omitted variables, measurement errors, and auto-correlation in the errors.

The Hansen-Sargan test (J test) of over-identifying restrictions and the test for the non-existence of first order (*m1*) and second order (*m2*) serial correlation in the differenced residuals are reported. The J test is asymptotically distributed as chi-square with degrees of freedom equal to the difference between the number of instruments and the number of parameters. The test for second-order serial correlation in residuals of differenced equations, *m2*, is asymptotically normally distributed under the null of no second-order serial correlation. However, Equations (5.3) - (5.9) are consistently estimated by OLS with fixed effects and heteroskedasticity consistent errors (see, Elsas et al., 2013; Faulkender et al., 2012; Warr et al., 2012). According to Warr et al. (2012), estimating the speed of adjustment in the second stage of the two-stage procedure by system GMM would gain little econometrically over using OLS. Further, using OLS in the second stage allows for direct comparisons with previous studies that have used a similar approach.[24]

5.4 Empirical results

The presentation of the empirical results is organised as follows: Section 5.4.1 presents estimation results of the target leverage; Section 5.4.2 presents estimation results on leverage adjustments using the two-step procedure and assuming symmetrical adjustments as well as difference in leverage adjustments between innovative firms (INN) and non-innovative firms (NIN); Section 5.4.3 presents estimation results on

[23]The other methods used in estimating dynamic models include, ordinary least squares (OLS), standard fixed effects (FE), long differencing (LD) (Huang and Ritter, 2009), difference GMM (DIFF GMM) (Arellano and Bond, 1991), and least squares dummy variable (LSDV) (Kiviet, 1995).

[24]For robustness, estimates of the speed of adjustment using system GMM in the second stage of the two-stage procedure are presented where appropriate.

leverage adjustments assuming asymmetry in leverage adjustments; Section 5.4.4 presents estimation results on the effects of financing deficits on leverage adjustments; and Section 5.4.5 presents results on the time variation in leverage adjustments.

5.4.1 Determinants of target leverage

Table 5.1 presents the estimating results of Equations (5.1) and (5.2) that relate leverage to lagged leverage, research and development (R&D), capital expenditure (Capex), tangible assets, intangible assets, growth, size, profit, non-debt tax shield, and earnings volatility. The first column, ALL, presents the results for all firms using Equation (5.1). The second and third columns present results of Equation (5.1) estimated separately for non-innovative (NIN) and innovative (INN) firms, respectively. The fourth and fifth columns of Table 4.2 present results of estimating Equation (5.2) for both innovative and non-innovative firms. The last column presents *p*-values for a *t*-test of the difference in the coefficients (NIN-INN) of columns four and five. The values in parentheses are the associated standard errors. All models include firm fixed effects and time dummies (not reported) to control for other excluded firm-specific and time factors that might affect leverage.

Coefficient estimates on lagged leverage are highly significant in all columns, which suggests that leverage is largely persistent. This indicates that prior debt financing levels are an important factor affecting current leverage levels. Firms with current debt financing are more likely to continue using debt financing in the future.[25] The implied speed of adjustment in Table 5.1, $\lambda = 1-\gamma$, for the full sample, ALL, is 24.2%. Using half a life convention $(ln(0.5)/ln(1-\lambda))$, this slow to moderate speed of adjustment implies that firms in the UK take 5 years (or a half-life of 2.50 years) on average to revert to their target leverage.

More generally, the slow to moderate implied speed of adjustment using the one-step

[25] This result that is consistent with Lemmon et al. (2008) who report that capital structure of firms in the US is highly persistent. Similarly, Hanousek and Shamshur (2011) report that the stability of leverage ratios is relatively unaffected by changes in the economic environments.

Table 5.1 The determinants of the target leverage

The table presents estimation results of Equations (5.1) and (5.2) that relate leverage to lagged leverage and lagged firm characteristics (research and development (R&D), capital expenditure (Capex), growth, tangible assets (tangible), intangible assets (intangible), size, profit, non-debt tax shield, and earnings volatility). ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. The results are estimated by system GMM. The table reports the *J statistic* from a test of the over identifying restrictions, and the *J statistic* is asymptotically distributed as chi-squared under the null of instrument validity, and the test of second-order autocorrelation (*m2*) in the first differenced residuals. Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Variables	ALL	NIN	INN	NIN	INN	Diff (p-value)
L_{it-1}	0.758***	0.823***	0.676***	0.840***	0.675***	(0.005)
	(0.032)	(0.049)	(0.043)	(0.045)	(0.042)	
R&D	-0.146***		-0.181***		-0.173***	(0.000)
	(0.034)		(0.041)		(0.039)	
Capex	0.114***	0.143**	0.046	0.163***	0.042	(0.063)
	(0.036)	(0.057)	(0.039)	(0.053)	(0.040)	
Tangible	0.058***	0.037**	0.087***	0.038**	0.089***	(0.014)
	(0.011)	(0.016)	(0.024)	(0.015)	(0.017)	
Intangible	0.046***	0.033*	0.071***	0.023	0.076***	(0.008)
	(0.012)	(0.018)	(0.018)	(0.017)	(0.016)	
Growth	0.000	-0.001	0.000	-0.001	0.001	(0.554)
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	
Size	0.005***	0.005***	0.005***	0.004***	0.005***	(0.500)
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
Profit	-0.180***	-0.206***	-0.176***	-0.197***	-0.170***	(0.359)
	(0.015)	(0.022)	(0.023)	(0.021)	(0.022)	
NDTS	-0.283***	-0.238***	-0.255***	-0.300***	-0.209***	(0.405)
	(0.061)	(0.090)	(0.094)	(0.084)	(0.075)	
Volatility	-0.114***	-0.130***	-0.105**	-0.104***	-0.092**	(0.828)
	(0.027)	(0.047)	(0.042)	(0.040)	(0.040)	
Constant	-0.009	-0.004	-0.015	-0.018		
	(0.013)	(0.026)	(0.043)	(0.015)		
N	7579	2945	4634	7579		
m2	1.083	0.680	0.751	0.995		
p-value	(0.279)	(0.497)	(0.453)	(0.320)		
J	67.517	68.848	68.287	139.100		
p-value	(0.562)	(0.517)	(0.536)	(0.506)		

procedure for all firms is within the range documented in the literature. US studies that report slow to moderate speed of adjustment include Dang et al. (2014a) (18.3% - 52.8%), Faulkender et al. (2008) (21.3% - 33.9%), Faulkender et al. (2012) (21.9% - 56.4%) and Flannery and Rangan (2006) (34.4%). The slow to moderate speed of adjustment in the literature has largely been attributed to the presence of adjustment costs (see, Leary and Roberts, 2005). In the presence of adjustment costs, firms adjust leverage towards the target only if benefits outweigh the associated costs (see, Byoun, 2008; Faulkender et al., 2008; Leary and Roberts, 2005). In contrast to studies that report significantly higher speed of adjustment, Fama and French (2002) and Kayhan and Titman (2007) report relatively low rates of 7% - 18% and 8.3% - 10%, respectively. The rather low and insignificant speed of adjustment reported by the latter studies in the US does not support the existence of a target capital structure as postulated by the trade-off theory.[26] The heterogeneity in the estimates of the speed of adjustment, even within the US, highlights the need for further research on the sources of the differences, and whether similar variations in target financing behaviour obtain in other economies where studies are rather limited.

This chapter extends the literature by examining whether differences in the type of investment that firms engage in is a source of heterogeneity in target financing behaviour. Consistent with the hypothesis that the types of corporate investment leads to heterogeneity in leverage adjustments, the differences in the estimates of the implied speed of adjustment $(1-\gamma)$ from Equation (5.2) between non-innovative (third column) and innovative (fourth column) firms are statistically significant. The estimates of the implied speed of adjustment for non-innovative firms is 17.7% $(1-0.823)$ and for innovative firms is 32.4% $(1-0.676)$. Whereas innovative firms take about 4 years (or a half-life of 1.76 years) to adjust towards the target leverage, non-innovative firms take almost 8 years (or a half-life of 3.98 years). The fifth and sixth columns show similar differences in the implied speed of adjustment $(1-\gamma)$. The relatively high implied speed of adjustment for innovative firms, which is almost twice as fast as that of non-innovative firms, suggests that the costs of deviating form the target capital structure are higher for innovative firms. These differences are preliminary evidence that recognising heterogeneity in target financing behaviour arising from differences in corporate investments is important in the understanding of variations in corporate capital structure.[27]

The results in Table 5.1 show a significant negative effect of R&D on leverage, which is consistent with the financial constraint proposition (Brown et al., 2012; Borisova

[26] Similarly, Welch (2004) reports that firms in the US do not actively seek to re-balance capital structure after experiencing shocks from changes in stock prices.

[27] Theories on information asymmetry posit that firms subject to information asymmetry face high bankruptcy costs (Myers, 1984; Myers and Majluf, 1984). The significant difference on the implied speed of adjustment shows the existence of asymmetry in target financing behaviour, as it is more beneficial for innovative firms to more actively re-balance towards the target so as to reduce the costs of deviating from the optimal capital structure.

and Brown, 2013; Hall, 2009; Hall et al., 2009). Firms undertaking R&D tend to use less debt on average as innovative investments are a poor form of collateral and are more prone to information asymmetry and asset substitution problems (Aghion et al., 2004). However, Figure 3.1 in Chapter 3 shows that there are instances when innovative firms have relatively higher leverage than non-innovative firms.[28] In contrast, fixed capital investments have a significant positive effect on leverage. This implies that firms undertaking fixed capital investments are more likely to find it easier to access financing from capital markets. Firms with innovative investments are subject to binding financial constraints which limits their access to capital markets (see, Brown et al., 2012).

Estimates of the coefficients on the other factors used as control variables are generally consistent with the literature.[29] Leverage is significantly positively related to tangible assets, intangible assets and size, while it is negatively related to growth, profitability and non-debt tax shield. The positive effect of tangible assets and size on leverage is consistent with the proposition that larger firms with more pledgeable assets find it easier to access capital (see, Almeida and Campello, 2007; Berger et al., 2011; Campello and Graham, 2013; Ortiz-Molina and Phillips, 2014). Contrary to the predictions of information asymmetry theories, the positive coefficient on intangible assets suggests that intangible assets support debt financing.[30] However, the significantly positive relationship with intangible assets are consistent with Lim et al. (2014) who purports that intangible assets reported in the purchase price allocation data of the bidding firms'10-Ks or 10-Qs in the US are positively correlated with debt.[31] Recently, Begenau and Palazzo (2015) report that some informed or in-

[28]Estimates of the coefficients on R&D in Figure 4.1 (Chapter 4) reveals that although the relationship between leverage and R&D is mostly negative, it sometimes is smaller in magnitude and insignificant in some cases.

[29]See studies on the determinants of capital structure (e.g., Cook and Tang, 2010; Dang, 2013a; Elsas and Florysiak, 2013; Faulkender et al., 2008, 2012).

[30]Figure 3.2 in Chapter 3 shows that the proportion of intangible assets on corporate balance sheets has increased substantially over time. However, extant studies have largely overlooked the role of intangible assets in corporate financing decisions despite theoretical studies which show that contract incompleteness and limited enforceability subject firms to binding financial constraints (see, Hart and Moore, 1994; Holmstrom and Tirole, 1997).

[31]A Form 10-K (10-Qs) is an annual (or quarterly) report that presents comprehensive information on the company's performance for the period under review. Every listed company in the US is required to submit Form 10-K (10-Qs) to the US Securities and Exchange Commission (SEC).

tegrated lenders recognise the value of specialised collateral and advance credit at relatively lower rates than uninformed lenders who charge a premium to compensate for the information asymmetry in collateral values. Consistent with the pecking order theory, firms use profits to reduce debt (negative coefficient estimates) and substitute debt tax shield for non-debt tax shield (see, DeAngelo and Masulis, 1980).

The results in Table 5.1 are used to compute the target leverage, which is used in the rest of this chapter. All the following sections use the two-step procedure to estimate the speed of adjustment.

5.4.2 Symmetric leverage adjustments

This section examines whether firms engage in target financing behaviour and whether this behaviour differs between innovative and non-innovative firms. Firms are also divided into sub-samples based on whether they are above or below target leverage. Further sub-division into innovative (*INN*) and non-innovative (*NIN*) groups are based on whether a firm reports R&D or not. Table 5.2 presents the estimation results of Equations (5.3) and (5.4) that relate changes in book leverage (ΔL_{it}) to the deviation (Dev_{it}) from target leverage.

Table 5.2 reports highly significant coefficients on the deviation from the target leverage. This provides supporting evidence to the predictions of the trade-off theory that firms actively re-balance capital structure. The significant speed of adjustment estimated using the two-step procedure in Table 5.2 is consistent with estimates using the one-step procedure in the previous section (Section 5.4.1). Under the dynamic trade-off theory, firms make leverage adjustments only when the marginal benefits associated with such adjustments outweigh the marginal costs. Using simulations, Leary and Roberts (2005) show that different forms of adjustment costs affect target adjustment behaviour, as fixed adjustment costs generate infrequent but large adjustments, and proportional adjustment costs generate small but more frequent leverage adjustments.

Table 5.2 Symmetric leverage adjustments

The table presents estimation results of Equations (5.3) and (5.4) that relate change in book leverage to deviation of actual leverage from target leverage. *RDD* is a dummy variable taking the value of one for innovative firms and zero otherwise. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3. All variables used are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream. All regressions include firm fixed effects and time dummies (not reported). Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Variables	ALL	NIN	INN	ALL
Dev_{it}	0.349***	0.288***	0.446***	0.283***
	(0.013)	(0.016)	(0.019)	(0.015)
$Dev_{it} \times RDD$				0.165***
				(0.022)
N	7579	2945	4634	7579
$Adj.R^2$	0.281	0.28	0.31	0.297

From the first column of Table 5.2, the estimate of the average speed of adjustment for all firms is 34.9%, assuming homogeneous target financing behaviour. This slow to moderate speed of adjustment can be attributed to the existence of adjustment costs. Several models show that adjustment costs reduce the speed of adjustment (e.g., Leary and Roberts, 2010; Korajczyk and Levy, 2003; Strebulaev, 2007).[32] Using the half-life convention, this implies that, on average, firms in the UK take 3.22 years (or a half-life of 1.61 years) to adjust towards the target leverage. This slow to moderate speed of adjustment is within the ranges reported in the literature (e.g., Antoniou et al., 2008; Flannery and Rangan, 2006). However, Dang et al. (2012) and Lockhart (2014) report relatively higher speeds of adjustment of 45% in the UK over the period 1996–2003 and 50% - 77% in the US over the period 1996-2006. [33] There are wide disparities in the speed of adjustment across studies even within the same economy (studies in the US use similar data sets from Compustat files) (see, Elsas and Florysiak, 2011). According to a review of the methods used in estimating dy-

[32] This result of slow to moderate speed of adjustment is consistent with recent studies that report high leverage persistence in the US (see, Denis and McKeon, 2012; Lemmon et al., 2008), and other economies in transition (see, Hanousek and Shamshur, 2011). Similarly, the slow to moderate speed of adjustment is also consistent with Brav (2009) who reports a speed of adjustment of 10.2% - 22.5% for firms in the UK over the period 1997-2003. Other studies in the UK report, for example, Dang et al. (2012) (dynamic panel threshold models estimated using DIFF GMM) and Ozkan (2001) (dynamic panel data models estimated using DIFF GMM) report relatively higher speeds of adjustment of 53% - 59% and 56.9% over the periods 1996–2003 and 1984-1996, respectively.

[33] Dang et al. (2012) employ a dynamic panel threshold model in which the speed of adjustment is estimated using difference GMM.

namic panel data (DPD) models in corporate finance by Flannery and Hankins (2013), the use of different estimation techniques (e.g., OLS, standard fixed effects (FE) estimation, difference GMM (DIFF GMM) (Arellano and Bond, 1991), system GMM (SYS GMM) (Blundell and Bond, 1998) and long differencing (LD) (Hahn et al., 2007; Huang and Ritter, 2009) and corrected least-squares (LS) (Kiviet, 1995)) is one source of the observed disparities in the speed of adjustment across studies.[34] Dang et al. (2014b) further show that estimates of the speed of adjustment are understated and overstated when using OLS and standard fixed effects (FE) techniques, respectively. They conclude that estimates of the speed of adjustment using GMM are consistent, while traditional methods such as least squares approach yield flawed estimates.[35]

Further, a comparison of the speed of adjustment shows that innovative firms (second column) adjust leverage one and half-times faster than non-innovative firms (third column). The fourth column shows that the difference in the estimate of the average speed of adjustment between innovative and non-innovative firms (16.5%) is significant. This result highlights that the marked changes in the composition of firms, which have been overlooked in the literature, affect target financing behaviour.[36] Similarly, Buera and Kaboski (2012) highlight that studies on the US that ignore changes within firms tend to overlook important effects of changes in the composition of firms on cash holdings. Prior studies use relatively shorter sample periods which may not adequately examine changes in firm composition. The average life of a US firm from the Compustat files is only 8-10 years (see, Dang et al., 2014a; Flannery and Hankins, 2013). Hence, studying capital structure decisions for longer periods, as done in this chapter, can help shed light on how changes in firm characteristics affect corporate financing decisions.

The assumption of homogeneous target financing behaviour is rather restrictive as

[34] Appendix 5.A presents a list of studies on target financing behaviour in the US, the UK and other countries.

[35] Dang et al. (2014b) also show analytical or bootstrap bias corrections approaches provide reliable estimates of the speed of adjustment.

[36] For example, there is evidence that IPOs are now dominated by young high growth firms (e.g., Fama and French, 2001, 2005) and that there has been a marked increase in innovative firms over the past decades (Brown and Petersen, 2009).

it tends to overlook variations in both the costs and benefits of leverage adjustments conditional on the initial deviation from the target leverage (see, Byoun, 2008; Dang et al., 2012, 2014a; Shyam-Sunder and Myers, 1999). It is rather more reasonable to assume that firms that are above the target leverage benefit more from leverage adjustments than firms that are below the target leverage since financial distress costs increase monotonically with leverage (see, Byoun, 2008). For example, Mukherjee and Wang (2013) report that the marginal costs of bankruptcy increase at a faster rate with deviation from target leverage. Also, Korteweg (2010) present a model which shows that the value function of a firm is increasing for firms below the target leverage, and decreases significantly with further increases in leverage. The next section investigates heterogeneity in leverage adjustments depending on whether the firm is above or below the target leverage and whether it reports R&D or not.

5.4.3 Asymmetric leverage adjustments

Table 5.3 presents the estimation results of Equations (5.5) and (5.6) that relate changes in book leverage to the deviation from the target leverage. The tabulated results are based on the assumption that firms undertake heterogeneous leverage adjustments depending on whether the firm is above or below target leverage. The results in the first, second and third columns are estimates from Equation (5.5), while the results in the fourth column are estimates from Equation (5.6).

The results in the first column of Table 5.3 show that allowing for asymmetry in the dynamic models reveals marked differences in target financing behaviour as firms that are above-target leverage have a relatively higher speed of adjustment (44.2%) compared to firms that are below-target leverage (27.8%). The reported speeds imply that firms that are above-target leverage take 2.38 years (or a half-life of 1.19 years) to adjust towards the target while firms that are below-target take 4.26 years (or a half-life of 2.13 years) to adjust towards the target. The significant difference in the speed of adjustment is consistent with the proposition that financial distress costs or bankruptcy costs increase with leverage. Thus, firms that are above-target benefit

Table 5.3 Asymmetric leverage adjustments

The table presents estimation results of Equations (5.5) and (5.6) that relate change in book leverage to deviation of actual leverage from target leverage. *RDD* is a dummy variable taking the value of one for innovative firms and zero otherwise. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3. All variables used are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream. All regressions include firm fixed effects and time dummies (not reported). Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Variables	ALL	NIN	INN	ALL
Dev_{it}^{Above}	0.442***	0.359***	0.515***	0.349***
	(0.019)	(0.024)	(0.028)	(0.023)
$Dev_{it}^{Above} \times RDD$				0.170***
				(0.035)
Dev_{it}^{Below}	0.278***	0.245***	0.374***	0.241***
	(0.019)	(0.023)	(0.032)	(0.023)
$Dev_{it}^{Below} \times RDD$				0.134***
				(0.038)
N	7579	2945	4632	7577
$Adj.R^2$	817	0.286	0.313	0.301

more from adjustment than firms that are below-target. Byoun (2008), Faulkender et al. (2012) and Korteweg (2010) report similar differences between firms with above and below-target in the US. An alternative rationale which arises from the need to preserve financial slack or flexibility deliberately by maintaining leverage below the target, may also explain the low speed of adjustment for firms with below-target leverage. de Jong et al. (2012), Denis (2011), Devos et al. (2012), Gamba and Triantis (2008) and Varouj Aivazian (2002) also highlight that maintaining financial slack, which can take the form of an untapped borrowing facility or excess cash, is optimal if firms seek to maintain flexibility that allows them to invest in profitable future opportunities.

A comparison across firm types reveals rather strikingly different results as innovative firms consistently have higher speed of adjustment than non-innovative firms. The estimation results of Equation (5.5) on separate sub-samples of firm types in the second and third columns show that the speed of adjustment for innovative firms with above-target leverage (51.5%) is higher than that of non-innovative firms with above-target leverage (35.9%). Similar differences are also observed between innovative firms with below-target leverage (37.4%) and non-innovative firms with below-target leverage (24.5%). The higher speed of adjustment for innovative firms is contrary to the proposition that innovative investments (R&D) subject firms to binding financial constraints, thereby, leading to slow speeds of adjustment. Rather, the evidence that innovative firms have a relatively higher speed of adjustment is consistent with the results shown in Figure 4.3 that innovative firms (with high growth rates) access capital markets more frequently than non-innovative firms, thereby having more opportunities to implement leverage adjustments. Also, the higher speed of adjustment for innovative firms suggests that high financial distress costs associated with innovative investments may impose greater costs of deviating from the target leverage, which forces firms to adjust capital structure more actively.

The differences in the speed of adjustment across firms of different types of investment are more pronounced and significant under the assumption of asymmetric leverage adjustments. Comparisons of the estimated speed reported in the fourth column of Table 5.3 suggests that innovative firms with above-target leverage have a 17.0% faster speed of adjustment than non-innovative firms with above-target leverage. The estimated speeds imply that innovative firms with above-target leverage take 1.9 years (or half-life of 0.95 years) on average to adjust towards the target, whereas non-innovative firms with above-target leverage take 3.22 years (or half-life of 1.61 years). Comparisons of firms with below-target leverage show that innovative firms have relatively higher speed of adjustment (37.5% which translates to 2.94 years or half-life of 1.47 years) than non-innovative firms (24.1% which translates to 5.02 years or half-life of 2.51 years). Thus, innovative firms adjust faster whether they are below or above-target.[37] These significant differences in speeds suggest that firms that face higher bankruptcy costs adjust faster towards the target, and that models of leverage adjustments that do not account for asymmetry overlook important dynamics on target financing behaviour.

The next sub-section further investigates the differences in leverage adjustments

[37] A study on the US by Dierker et al. (2013) investigating whether firms adjust leverage to manage risk reports results that are consistent with those reported in this section as firms with high risk adjust faster than firms with low risk.

between innovative firms and non-innovative firms by examining effects of financing imbalances on the speed of adjustment.

5.4.4 Financing deficits and leverage adjustments

This section investigates the effects on leverage adjustments of cash-flow imbalances, which take the form of financing surpluses or deficits. Following Byoun (2008) and Faulkender et al. (2012), financing imbalances offer convenient opportunities to adjust leverage at relatively lower costs as the firms need to issue large amounts of debt/equity to cover the financing deficit. This section extends these findings by examining whether the effects of financing deficits differ systematically between firms with above-target leverage and those with below-target leverage, and between non-innovative and innovative firms.

Table 5.4 presents the estimation results of Equations (5.7) and (5.8) in Panel A, and Equations (5.9) and (5.10) in Panel B that relate changes in book leverage to the deviation from the target leverage. The results in Panel A are based on the assumption of symmetric target financing behaviour, while the results in Panel B are based on the assumption of asymmetric target financing behaviour. The results in the first, second and third columns of Panel A are estimates from Equation (5.7), while the results in the fourth column are estimates from Equation (5.8). The results in the first, second and third columns of Panel B are estimates from Equation (5.9), while the results in the fourth column are estimates from Equation (5.10). The effects of the financing deficit on leverage adjustment in Table 5.4 is examined by using the financing deficit dummy variable (FD_{it}) that takes the value of one if a firm has a financing deficit and zero otherwise.

The estimated coefficients on the effects of the financing deficit on leverage adjustment in Panel A are rather insignificant, except those reported in the fourth column. Focusing on the results in the fourth column of Panel A, the presence of a financing deficit reduces the speed of adjustment for non-innovative firms by 10% (an increase

Table 5.4 Leverage adjustments and financing deficits

The table presents estimation results of Equations (5.7) and (5.8) in Panel A, and Equations (5.9) and (5.10) in Panel B that relate change in book leverage to deviation of actual leverage from target leverage. *RDD* is a dummy variable taking the value of one for innovative firms and zero otherwise. FD_{it} is a dummy variable taking the value of one for firms with a financing deficit and zero otherwise. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3. All variables used are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream. All regressions include firm fixed effects and time dummies (not reported). Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Panel A: Symmetric leverage adjustments with financing deficits

Variables	ALL	NIN	INN	ALL
Dev_{it}	0.359***	0.310***	0.427***	0.359***
	(0.012)	(0.015)	(0.021)	(0.012)
$Dev_{it} \times FD_{it}$	-0.028	-0.053*	0.071	-0.100***
	(0.026)	(0.027)	(0.049)	(0.028)
$Dev_{it} \times FD_{it} \times RDD$				0.237***
				(0.052)
N	7579	2945	4634	7579
$Adj.R^2$	0.282	0.283	0.311	0.292

Panel B: Asymmetric leverage adjustments with financing deficits

Variables	ALL	NIN	INN	ALL
Dev_{it}^{Above}	0.375***	0.304***	0.442***	0.371***
	(0.020)	(0.024)	(0.031)	(0.020)
$Dev_{it}^{Above} \times FD_{it}$	0.235***	0.212***	0.243***	0.162***
	(0.034)	(0.041)	(0.051)	(0.040)
$Dev_{it}^{Above} \times FD_{it} \times RDD$				0.145**
				(0.058)
Dev_{it}^{Below}	0.354***	0.330***	0.411***	0.356***
	(0.019)	(0.023)	(0.035)	(0.019)
$Dev_{it}^{Below} \times FD_{it}$	-0.155***	-0.149***	-0.106*	-0.184***
	(0.028)	(0.029)	(0.062)	(0.029)
$Dev_{it}^{Below} \times FD_{it} \times RDD$				0.136**
				(0.057)
N	7579	2945	4634	7579
$Adj.R^2$	0.308	0.312	0.324	0.311

of 1.5 years or a half-life of 0.75 years) compared to the 35.9% (3.12 years or a half-life of 1.56 years) reported when there is no financing deficit. However, the presence of a financing deficit increases the speed of adjustment of innovative firms to 49.6% (35.9% - 10.0% + 23.7%). The increase in the speed of adjustment with a financing imbalance is consistent with the proposition that financing imbalances offer an opportunity to adjust leverage at relatively low cost than would be the case without a deficit (e.g., Byoun, 2008; Dang et al., 2014a; Faulkender et al., 2012). This higher speed of adjustment for innovative firms with a financing deficit shows that, in the UK, it is innovative firms rather than non-innovative firms that use most of the opportunities presented by a financing imbalance to re-balance capital structure.

This difference in the speed of adjustment between innovative and non-innovative firms conditional on the presence of a financing deficit highlights another source of asymmetry in target financing behaviour that has not be considered in the literature.

The increase in the speed of adjustment for innovative firms with financing deficits is also consistent with the hypothesis that the shortfall in financing offers an opportunity to adjust leverage while simultaneously accessing capital markets to finance profitable investments.[38] According to Byoun (2008), the benefits arising from combining financing the investment opportunities and adjusting leverage are more likely to outweigh the costs associated with accessing capital markets to make leverage adjustments, especially, with the increasing levels of debt. After incorporating the effects of financing imbalances on leverage adjustments, innovative firms have a speed of adjustment (2.02 years or half-life of 1.01 years) that is twice as fast as that of non-innovative firms (4.62 years or half-life of 2.31 years). This difference in the speed of adjustment suggests the existence of heterogeneous target financing behaviour conditional on investment types, which becomes more pronounced in the presence of financing imbalances. This result shows that recognising the effect of different forms of investment on target financing behaviour is an important factor in understanding the observed variations in leverage adjustments in addition to the factors already identified in the literature.[39]

Panel B of Table 5.4 presents results on the effects of financing imbalances on firms with above and below target leverage. Financing deficits have a consistent positive and significant effect on the speed of adjustment for firms with above-target leverage. The effect is higher for innovative firms that have a speed of adjustment of 67.8% (1.44 years or half-life of 0.72 years) relative to 53.3% (2.18 years or half-life of 1.09 years) for non-innovative firms. While the effects of a financing deficit on lever-

[38] Borisova and Brown (2013) and Brown et al. (2012) report US firms engaging in R&D are subject to financing constraints, which increase the cost of capital. The benefits of accessing capital markets are more likely to outweigh the costs when firms need to adjust leverage while they have a financing imbalance.

[39] For a review of factors affecting financing decisions, see, inter alia, Frank and Goyal (2009) and Oztekin (2015).

age adjustments is consistently negative for firms with below-target leverage, it is significant for non-innovative firms and rather marginally significant for innovative firms. Using the half-life convention, the result in the last column of Panel B implies that firms without a financing deficit and below-target leverage take 3.16 years (or a half-life of 1.58 years) (35.6%) to adjust towards the target leverage. Non-innovative firms with similar conditions take 7.16 years (or a half-life of 3.58 years) (17.2%) while innovative firms take 3.7 years (or a half-life of 1.85 years) (30.8%). Similar to the results in Panel A, the result in Panel B shows that financing imbalances have a different effect on the speed of adjustment for innovative and non-innovative firms. Prior studies on target financing behaviour have also not examined how different forms of investment affect the incentive to take advantage of financing imbalances when adjusting leverage. The results in Table 5.4 contribute new insights by showing that investment types, which have been overlooked in the literature, are a significant source of the observed heterogeneity in target financing behaviour.

The next section examines time variation in leverage adjustments over the period 1987 to 2013.

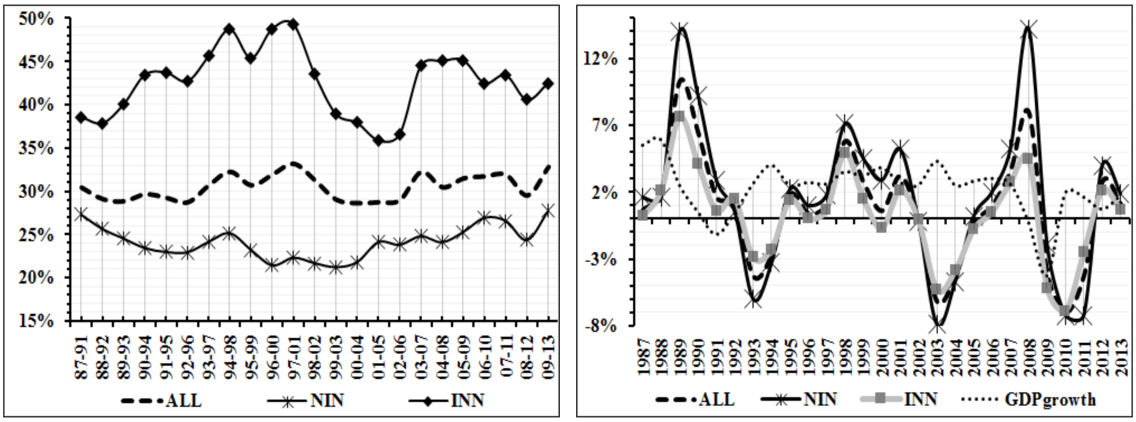
5.4.5 Time variation in leverage adjustments

This section builds on the above results by examining time variation in leverage adjustment. Figure 5.1 plots the speed of adjustment (λ) and the deviations from target leverage (Dev_{it}) obtained from estimations of Equation (5.3) over a 5-year rolling window for the period 1987-2013. The speed of adjustment is estimated separately for all firms (ALL), non-innovative firms (NIN) and innovative firms (INN).

Figure 5.1 reveals several new important dynamics on target financing behaviour. First, consistent with the results in Tables 5.1 - 5.4, Figure 5.1a shows that non-innovative and innovative firms adopt different financing behaviour. The speed of adjustment of innovative firms is consistently higher than that of non-innovative firms. The difference in the speed of adjustment narrows over the 5-year rolling win-

Figure 5.1 The evolution of leverage adjustments

(a) Speed of adjustment **(b) Deviation from target leverage**



dows from 1997 to 2006, increases temporarily thereafter, but decreases again over the period encompassing the global financial crisis.[40] The trade-off theory postulates that firms balance the debt tax-shield with financial distress costs. When financial distress costs are high, firms respond by adopting a conservative capital structure. However, Figure 3.1 in Chapter 3 presents evidence inconsistent with these implications, as innovative firms have similar debt levels as non-innovative firms (which face low financial distress costs). Rather, the evidence in Figure 3.1 of Chapter 3, taken together with the time series variations in the speed of adjustment (Figure 5.1), suggests that firms counteract the high bankruptcy costs associated with using debt financing by adjusting faster towards the target. This result is consistent with the theoretical prediction of the model of Krainer (2014) which shows that managers use capital structure to offset any deviations in operating risk from the thresholds that are acceptable to the shareholders.

Second, the speed of adjustment changes over time and exhibits relatively higher variability for innovative firms compared to non-innovative firms.[41] This high variability suggests that the reported changes in adjustment speeds around macroeco-

[40] Appendices 5.C and 5.E show the time series differences in the speed of adjustment between innovative and non-innovative firms, and it corroborates the results in Figure 5.1a. The trend line of the differences in the speed of adjustment in Appendix 5.C reveal a clear increase in differences over the 5-year rolling windows from 1987 to 2001 and the narrowing of the difference thereafter until 2006. Onwards, the trend line suggests that window periods that include the recent-crisis increased the differences in leverage adjustment.

[41] Appendix 5.C shows that the variability of the speed of adjustment of innovative firms is twice as high as that of non-innovative firms.

nomic events in the US by Cook and Tang (2010) could very well be due to adjustments by managers of innovative firms. Cook and Tang (2010) report that firms in the US adjust leverage faster (slower) in good (bad) macroeconomic environments.[42] The trends in the speed of adjustment in Figure 5.1a add new insights as it shows that much of the adjustments are done by firms (innovative) that face high costs of deviating from the target leverage.[43] The costs of deviating from target tend to increase with operating risk and deteriorating macroeconomic conditions. Figure 5.1a shows that the overlooked differences in corporate investments give rise to both cross-sectional and time series heterogeneity in leverage adjustments.[44]

Third, Figure 5.1b reveals that, on aggregate, firms in the UK are mostly under-levered relative to the target ($L^*_{it} - L_{it-1} > 0$), except during the periods 1993-1994, 2002-2005 and 2009-2011. A superimposed plot of GDP growth shows that periods of negative growth precede large temporary negative shocks in the deviation from target ($L^*_{it} - L_{it-1} < 0$) over the periods 1993-1994 and 2009-2011. The post-negative growth in GDP periods are marked by a reversal in deviation from target as firms become systematically under-levered.[45] The period from 2002 to 2005 is uniquely marked by an above average growth in GDP that coincides with a temporary negative shock in the deviation from target. The above-target leverage observed during

[42]Consistent with the result in Figure 5.1a, Appendix 5.I in which the speed of adjustment obtained from estimations of Equation (5.3) in 5 year rolling windows over the sample period is stacked in a vector $\mathbf{\Psi_t}$ that is regressed on a set of macroeconomic variables, $\mathbf{Z_{t\text{-}1}}$ (in Equation (5.11)), shows that the speed of adjustment of innovative firms is more sensitive to changes in macroeconomic conditions (GPD growth (GDPg), changes in interest rates (ΔIR) and inflation) than that for non-innovative firms.

[43]Appendix 5.D present plots of the mean target leverage (Panel A) and descriptive statistics of the target leverage (Panel B). Consistent with the prediction that innovative investments should be financed using equity (see, inter alia, Brown et al., 2009; Hall, 2002; Hall and Lerner, 2010), the results in Panel A and B show that innovative firms have a lower target leverage than non-innovative firms. Panel B also shows similar variation in the target leverage which suggests that the financing decisions (target financing behaviour) of innovative firms are influenced by the same factors as that of non-innovative firms.

[44]Byoun (2008), Flannery and Lockhart (2009), Hovakimian et al. (2009), Lockhart (2014) and Warr et al. (2012) report that financial constraints and credit-lines give rise to differences in the speed of adjustment. They show that unconstrained firms with credit-lines adjust faster than constrained firms without credit-lines. However, these studies have not explicitly examined time series variation in the speed of adjustment and how investment types affect target financing behaviour.

[45]The evolution of the deviation from target is consistent with the prediction of the dynamic contingent model of Bhamra et al. (2010) that leverage is pro-cyclical during refinancing periods but it is generally counter-cyclical in aggregate dynamics. Similarly, DeAngelo et al. (2011) report that firms in the US deliberately deviate from the target leverage by issuing transitory debt to fund investments.

this period is consistent with the predictions of the market timing theory that firms time the issuance of securities (in this case debt) to coincide with favourable macroeconomic environments.[46] Campello and Graham (2013) report similar results that market timing increased significantly in the run-up to the tech-bubble or dot-com boom in the US. Figure 4.3 in Chapter 4 shows that the proportion of firms issuing securities increased significantly over the period 2004-2006.

Overall, the results in Figure 5.1 provide new and strong evidence of cross-sectional heterogeneity in target financing behaviour linked to investment type. The understanding of cross-sectional heterogeneity in corporate decisions arising from differences in investments is important as economies are transiting from predominantly manufacturing sectors towards technological and service sectors, which brings a host of new challenges to traditional collateral-based financing.[47] Time variation in leverage adjustment has largely been overlooked in the literature. The results reported in this section suggest the existence of significant time variation in leverage adjustment. Further, this time variation is more pronounced for innovative firms than non-innovative firms. This result is new to the literature and, taken together with the relatively high speed of adjustment for innovative firms, conforms to the hypothesis that firms that are subject to high financial distress costs (with high operating risk) are more pro-active in re-balancing capital structure. These results are important as they show that corporate investments (in addition to the other factors already identified in the literature) are a significant and persistent source of heterogeneity in leverage adjustments. The time series variation in the speed of adjustment also sheds light on why results from studies over different sample periods are decidedly mixed in the US.

[46] For a review of studies on market timing, see Alti (2006), Baker and Wurgler (2002), Butler et al. (2011), Campello and Graham (2013), Chen and Chen (2012), Dittmar and Thakor (2007), Elliott et al. (2008) and Mahajan and Tartaroglu (2008).

[47] The financing of innovative investments which are characterised by high information asymmetry, asset substitution problems, long investment horizons and low collateral values due to high specificity remain largely a challenge that has to be addressed at government level particularly in the UK which lags behind other advanced economies. The need to understand the linkages between investment and financing activities and how they impact on financial stability and economic growth has never been more clear than in the aftermath of the recent global financing crisis where over-indebtedness was one of the main causes of the problems.

Table 5.5 Leverage adjustments: Other methods

The table presents estimation results of equations that relate change in book leverage to deviation of actual leverage from target leverage. Results in Column I are estimated from Equation (5.4) and results in Column II are estimated from Equation (5.6), with all equations being estimated using Fama and MacBeth (1973) (FM). Results in Column III are estimated from Equation (5.4) and results in Column IV are estimated from Equation (5.6), with all equations being estimated using system GMM (SYS GMM). *RDD* is a dummy variable taking the value of one for innovative firms and zero otherwise. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3. All variables used are winsorised at the 1$^{\text{th}}$ and 99$^{\text{th}}$ percentiles. The data is drawn from Worldscope through Datastream. The table reports the *J statistic* from a test of the over identifying restrictions, and the *J statistic* is asymptotically distributed as chi-squared under the null of instrument validity, and the test of second-order autocorrelation (*m2*) in the first differenced residuals. All regressions include firm fixed effects and time dummies (not reported). Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Variables	I	II	III	IV
Dev_{it}	0.240***		0.221***	
	(0.009)		(0.023)	
$\text{Dev}_{it} \times RDD$	0.177***		0.120***	
	(0.021)		(0.031)	
Dev_{it}^{Above}		0.302***		0.313***
		(0.020)		(0.021)
$\text{Dev}_{it}^{Above} \times RDD$		0.148***		0.159***
		(0.023)		(0.031)
Dev_{it}^{Below}		0.209***		0.194***
		(0.014)		(0.024)
$\text{Dev}_{it}^{Below} \times RDD$		0.161***		0.138***
		(0.029)		(0.032)
Method	FM	FM	SYS GMM	SYS GMM
N	7578	7579	7577	7577
m2			0.898	0.932
p-value			0.369	0.351
J			532.775	743.509
p-value			0.999	1.000

5.5 Robustness

This section presents a number of robustness checks. First, Table 5.5 presents estimation results of Equations (5.4) and (5.6) using the Fama and MacBeth (1973) (FM) procedure and system GMM (SYS GMM) to check the sensitivity of the results to the choice of the estimation method. In Table 5.5, the first and second columns are estimated using the Fama and MacBeth (1973) two-pass procedure, while the results in the third and fourth columns are estimated using system GMM.

The results presented in Table 5.5 remain qualitatively similar to those reported in Tables 5.2 and 5.3. Innovative firms (columns I and III) consistently exhibit a higher speed of adjustment than non-innovative firms. Also, firms with above-target leverage have a relatively higher speed of adjustment than firms with below-target leverage (columns II and IV), which is consistent with prior studies and results in Sections 5.4.2 and 5.4.3 of this chapter.[48] The results in columns II and IV also show that innovative firms consistently adjust faster than non-innovative firms whether they are below or above-target leverage.[49,50] The results in Table 5.5 show that the differences in the speed of adjustment between innovative and non-innovative firms are robust to different estimation methods.

Finally, this section examines the sensitivity of the results to different measures of leverage, as there is an ongoing debate on the definition of leverage. For example, Barclay et al. (2006), Fama and French (2002) and Graham and Harvey (2001) prefer book-based measures, while Dang et al. (2012), Frank and Goyal (2007a) and Welch (2004) prefer market-based measures.[51] Instead of using total debt (TDA) as in the previous sections, Equations 5.1 and 5.2 are estimated in Table 5.6 using long-term debt (LTDA) as leverage. A significant coefficient on lagged long-term debt implies that firms have a target debt maturity. Estimates of the coefficients on lagged long-term debt from the one-step approach in Table 5.6 are highly significant. The implied speed of adjustment of 28.8% on long-term debt for all firms, ALL, in Table 5.6 is relatively higher than that reported in Table 5.1 for total debt (24.2%). This implied speed of adjustment ($\lambda = 1 - \gamma$) towards the target debt maturity is slow to moder-

[48]Similarly, Byoun (2008), Faulkender et al. (2012) and Warr et al. (2012) report significant asymmetries in the speed of adjustment between above-target and below-target leverage in the US over the period 1971-2003, 1965-2006 and 1971-2008, respectively.

[49]Appendix 5.H shows the results estimated using an unbalanced dynamic panel data with a fractional dependent variable (DPF) estimator. Chang and Dasgupta (2009), Elsas and Florysiak (2011) and Iliev and Welch (2010) highlight that empirical studies that fail to consider the fractional nature of leverage (leverage is ratio bounded in the interval [0,1]) tend to overstate estimates of the speed of adjustment. According to Elsas and Florysiak (2011), the DPF estimator is a doubly-censored tobit estimator ([0,1]), which relies on a latent variable approach to explicitly account for the fractional nature of leverage. The DPF is implemented in this chapter using Stata *xttobit*. Drobetz et al. (2015) and Elsas and Florysiak (2011, 2013) use a similar approach.

[50]Similarly, Appendix 5.H shows that there are significant differences in the speed of adjustment between innovative and non-innovative firms, even after taking into consideration the fractional nature of leverage.

[51]Barclay et al. (2006) highlight that there is no particular economic reason to expect the same or similar results when comparing the results that use market-based and book-based measures of leverage. Similarly, Rajan and Zingales (1995) argue that the appropriate measure of leverage depends on the objectives of the study. However, Bessler et al. (2011), Graham and Harvey (2001) and Stonehill et al. (1975) argue that managers base their decisions on book-based measures rather than market-based measures of capital structure that are affected by other events unrelated to the company (stock market shocks).

Table 5.6 Debt maturity adjustments: Non-innovative versus Innovative firms

The table presents estimation results of Equations (5.1) and (5.2) that relate long-term debt to lagged long-term debt, research and development (R&D), capital expenditure (Capex), tangible assets, intangible assets, growth, size, profit, non-debt tax shield, and earnings volatility. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2, and are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream. The results are estimated by system GMM. The table reports the *J statistic* which is a test of the over identifying restrictions, and the *J statistic* is asymptotically distributed as chi-squared under the null of instrument validity, and the test of second-order autocorrelation (*m2*) in the first differenced residuals. Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Variables	ALL	NIN	INN	NIN	INN	Diff (*p*-value)
LTDA$_{it-1}$	0.712***	0.818***	0.599***	0.793***	0.610***	(0.002)
	(0.031)	(0.048)	(0.038)	(0.045)	(0.039)	
R&D	-0.059**		-0.063***		-0.062***	(0.008)
	(0.023)		(0.024)		(0.024)	
Capex	0.056*	0.099*	0.044	0.099*	0.021	(0.220)
	(0.031)	(0.060)	(0.031)	(0.057)	(0.032)	
Growth	0.000	0.001	0.000	0.000	0.000	(0.985)
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	
Tangible	0.067***	0.051***	0.097***	0.051***	0.087***	(0.061)
	(0.010)	(0.016)	(0.017)	(0.014)	(0.014)	
Intangible	0.069***	0.047***	0.083***	0.045***	0.089***	(0.024)
	(0.011)	(0.017)	(0.014)	(0.015)	(0.015)	
Size	0.005***	0.005***	0.006***	0.005***	0.005***	(0.886)
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
Profit	-0.069***	-0.081***	-0.063***	-0.078***	-0.059***	(0.359)
	(0.009)	(0.018)	(0.011)	(0.017)	(0.011)	
NDTS	-0.178***	-0.185*	-0.203***	-0.212**	-0.147**	(0.542)
	(0.053)	(0.095)	(0.075)	(0.091)	(0.063)	
Volatility	-0.037*	-0.058	-0.010	-0.050	-0.005	(0.263)
	(0.020)	(0.041)	(0.024)	(0.033)	(0.032)	
Constant	-0.049***	-0.058*	-0.085***	-0.057***		
	(0.011)	(0.032)	(0.031)	(0.013)		
SOA (λ)	0.288	0.182	0.401	0.207	0.390	
N	7579	2945	4634	7579		
m2	1.005	1.918	-0.349	1.146		
p-value	(0.315)	(0.055)	(0.727)	(0.252)		
J	70.774	79.458	82.215	158.856		
p-value	(0.452)	(0.206)	(0.151)	(0.131)		

ate as is consistent with prior studies in the US.[52,53] The relatively few studies that

[52]Several studies in the US report slow to moderate speed of adjustment using booked-based measures of leverage (e.g., Dang et al., 2014b; Hanousek and Shamshur, 2011; Hovakimian and Li, 2011; Huang and Ritter, 2009; Lemmon et al., 2008), and using both booked and market based measures of leverage (e.g., Fama and French, 2002; Flannery and Rangan, 2006; Hovakimian and Li, 2010; Kayhan and Titman, 2007).

[53]Similar slow to moderate speeds of adjustment are also observable on net-debt (NDA) and total debt (TDA) in Appendices 5.F, 5.G and 5.H as is consistent with the existence of adjustment costs. Using net-debt, the results in Appendix 5.F (one-step approach) show that the implied speed of adjustment is slow to moderate (19.9% - 41.4%) and that innovative firms (19.9%) consistently adjust faster than non-innovative firms (41.4%). Similar differences in the speeds of adjustment are also shown in Appendix 5.G using the two-step approach. These similar results (Appendices 5.F and 5.G) show that the differences between innovative and non-innovative firms remain statistically significant when using net-debt as leverage, and whether the one-step or the two-step approach is used. The implied speed of adjustment towards the target total debt (second column), target net-debt (sixth column) and target debt maturity (tenth column) in Appendix 5.H for all firms, ALL, is 29.3%, 39.9% and 29.1%, respectively. These results are qualitatively similar to those reported in Table 5.1 (24.2%) and 5.2 (34.9%), which shows that the differences in the speed of adjustment between non-innovative

examine whether firms have a target debt maturity report similar slow to moderate speed of adjustment due to the presence of adjustment costs. For example, Byoun (2008) reports a speed of adjustment of 21% - 24% for firms in the US adjust over the period 1971-2003, while Antoniou et al. (2006) report speed of adjustment of 33% - 34% in the UK, 51% - 54% in Germany and 53% - 55% in France over the period 1969-2000. Antoniou et al. (2006) conclude that the lower speed of adjustment of firms in the UK (when compared to France and Germany) is due to the low costs of deviating from the target debt maturity relative to costs of adjusting towards the target. In contrast to Antoniou et al. (2006) and Byoun (2008), Ozkan (2000) reports higher speeds of adjustment (32% - 46%) for firms in the UK over the period of 1983–1996, and concludes that firms in the UK face significant costs of deviating from target debt maturity structure. The results presented in the third and fourth columns of Table 5.6 show that the difference in the speed of adjustment between non-innovative firms (18.2%) and innovative firms (40.1%) is highly significant. Similarly, the results in the fifth (20.7%) and sixth (39%) columns estimated using Equation (5.2) show significant differences in the speed of adjustment between innovative and non-innovative firms. This result suggests that the two types of firms have different debt maturity targets and costs of adjustments.

Overall, the results in Tables 5.5 and 5.6 confirm that the findings in this study are robust to alternative estimation methods and definitions of leverage, and that innovative and non-innovative firms have different target financing behaviour.

5.6 Conclusion

This chapter examines the differences in leverage adjustments between innovative and non-innovative firms. The analysis in this chapter is motivated by the significant changes in corporate balance sheets as marked by an increase (decrease) in intangible

firms and innovative firms are robust to the choice of the definition of leverage (total debt, long-term debt and net-debt) and the use of either the one-step or the two-step approach in the estimation of the speed of adjustment. Appendix 5.A also presents a list of studies on target financing behaviour which shows wide variation in the estimates of the speed of adjustment across studies, countries and over time.

(tangible) investments. These changes should result in the adoption of conservative financing policies as the literature has established that intangible investments subject firms to binding financial constraints and that firms use capital structure to manage operating risks. However, it is not clear why leverage has remained relatively persistent and rising in general, and whether the forms of corporate investment are a source of the observed heterogeneity in target financing behaviour. This chapter contributes to the literature by examining whether firms engage in target financing behaviour, and if innovative firms (invest in R&D) and non-innovative firms (do not invest in R&D) differ in this behaviour. This chapter also examines asymmetry and time variations in leverage adjustments conditional on whether a firm is above or below target leverage, and whether it has a financing deficit or not. If the forms of investment undertaken by firms are of first order importance in setting corporate financing policy, then, the increase in intangible investments coupled with the concurrent decrease in tangible investments should affect the speed of adjustment and target financing behaviour. The differences in corporate investment should result in heterogeneity in the speed of adjustment between innovative and non-innovative firms. In order to examine the differences and time variation in the speed of adjustment, the analyses in this chapter estimate a series of dynamic panel data models on innovative firms and non-innovative firms in the UK over the period 1987-2013.

The results show that the behaviour of firms that engage in target financing is consistent with the predictions of the trade-off theory. The estimated speed of adjustment is slow to moderate, which is consistent with the existence of adjustment costs and previous studies in the US. This chapter presents evidence that accounting for asymmetry in target financing behaviour is important as firms with above-target leverage have a relatively higher speed of adjustment than firms with below-target leverage. Further, analyses in this chapter show that the speed of adjustment increases with the existence of a financing deficit as is consistent with the proposition that firms use the opportunity presented by the need to refinance or fund investment to also adjust leverage towards the target. Comparisons of leverage adjustments between innovative and non-innovative firms show significant differences as innovative firms consistently have a higher speed of adjustment than non-innovative firms. The relatively higher speed of adjustment for innovative firms is inconsistent with the proposition that firms that are subject to financial constraints have less flexibility in adjusting leverage, but is consistent with the proposition that firms adjust leverage to manage risk. As innovative firms have relatively high costs of bankruptcy, they tend to benefit more from keeping leverage close to the target. The differences in the speed of adjustment become even more pronounced if asymmetry in leverage adjustment and financing imbalances are taken into consideration. This result is new to the literature on target financing behaviour and show that innovative firms appear to take advantage of most of the opportunities presented by a financing imbalance to adjust leverage whether they have above or below-target leverage. These results are robust to the inclusion of other factors that have been associated with target financing behaviour.

Finally, the chapter presents evidence of significant time variation and asymmetry in leverage adjustment. The time series analyses show that there are significant differences in the speed of adjustment between innovative and non-innovative firms over time, with innovative firms consistently adjusting faster than non-innovative firms. The results also show that speed of adjustment of innovative firms exhibits greater variation than that of non-innovative firms. This provides further evidence that much of the observed re-balancing of capital structure is done by innovative firms which face higher operating risks and costs of deviating from target. The time variation in the speed of adjustment also suggests that the mixed results in the literature on the rate at which firms adjust leverage could be due to the changes in the speed of adjustment over time and the failure to consider heterogeneity in target financing behaviour conditional on the forms of corporate investment.

Overall, the results show that the forms of investment have a significant effect on leverage adjustment, and are important in the understanding of the asymmetry in target financing behaviour. Further research should examine heterogeneity in corporate decisions arising from different forms of investment as economies transit from predominantly manufacturing sectors towards technological and service based sectors.

Appendices to Chapter 5

Appendix 5.A List of previous studies on target financing behaviour

The table presents a list of previous studies on target financing behaviour. The tables reports the author(s), the speed of adjustment (λ), market, sample size (Observations/firms) and sample period.

Panel A: US Studies

Author(s)	SOA (λ)	Market	Sample size (Obs/firms)	Period
Byoun (2008)	20%-33.0%	USA	118731	1971-2003
Cook and Tang (2010)	43.7%-46.1%	USA	126920	1977-2006
Dang et al. (2014a)	18.3%-52.8%	USA	51894 (6232 firms)	2002–2012
Devos et al. (2013)	11%-30%	USA	67,210	1982-2009
Elsas and Florysiak (2011)	26%	USA	169787 (16357)	1965–2009
Fama and French (2002)	8%-15%	USA	3000 firms	1965-1999
Faulkender et al. (2008)	21.3%-33.9%	USA	125391 (14152 firms)	1965-2004
Faulkender et al. (2012)	21.9%-56.4%	USA	131062	1965–2006
Flannery and Rangan (2006)	34.4%	USA	111106 (12 919 firms)	1965-2001
Hovakimian and Vulanovic (2010)	8.9%-37.2%	USA	138631 (38631 firms)	1970–2007
Huang and Ritter (2009)	17.0%-23.2%	USA	112483	1963-2001
Iliev and Welch (2010)	–7%-5%	USA	132412(5804 firms)	1963–2007
Jalilvand and Harris (1984)	56%	USA	108 firms	1963-1978
Lemmon et al. (2008)	25%	USA	225839	1965-2003
Lockhart (2014)	50% - 77%	USA	41,696	1996-2006
Mukherjee and Wang (2013)	8.9%-22.1%	USA	129666 (10237 firms)	1965-2008
Warr et al. (2012)	27%–37%	USA	46666	1971-2008
Welch (2004)	0%	USA	60317	1962–2000

Panel B: UK Studies

Author(s)	SOA (λ)	Market	Sample size (Obs/firms)	Period
Brav (2009)	10.2%-22.5%	UK	354687	1997-2003
Dang et al. (2012)	53%-59%	UK	5393 (859 firms)	1996–2003
Ozkan (2001)	56.9%	UK	4132 (390 firms)	1984-1996

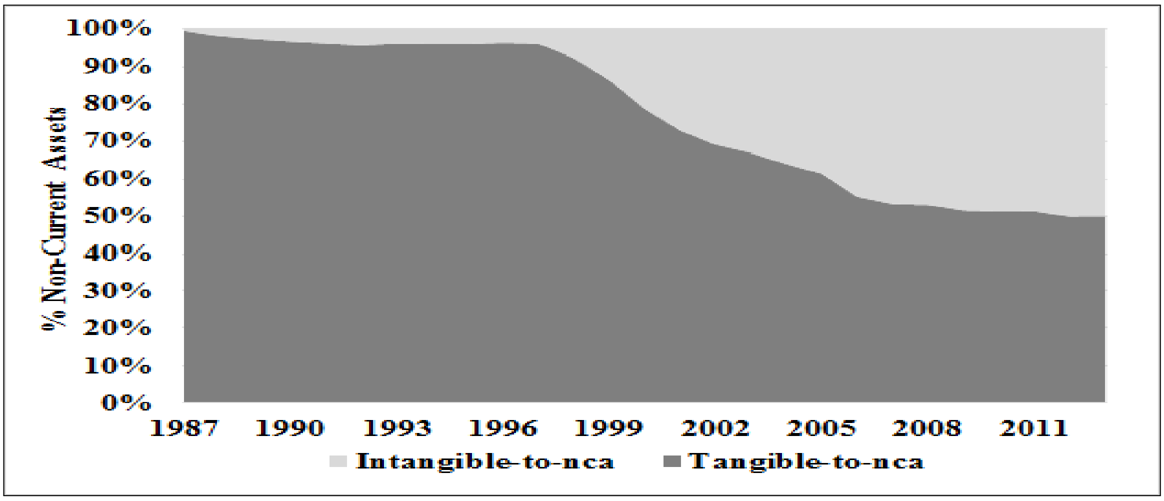
Panel C: International Studies

Author(s)	SOA (λ)	Market	Sample size (Obs/firms)	Period
Antoniou et al. (2008)	30.0%-50.0%	UK, US, France, Germany & Japan	57,134 (4,854 firms)	1987-2000
Halling et al. (2012)	11.7%-31.3%	18 countries	216178 (26280 firms)	1983-2009
Dang et al. (2010)	36.8%-57.2%	G-5 countries	78108 (9034 firms)	1980-2007
Drobetz and Wanzenried (2006)	10%-20%	Sweden	90 firms	1991–2001
Drobetz et al. (2015)	8%-26.8%	G-7 countries	125982	1991-2009
Oztekin and Flannery (2012)	4.0%-41.0%	World (37 countries)	105568 (15177 firms)	1991-2006

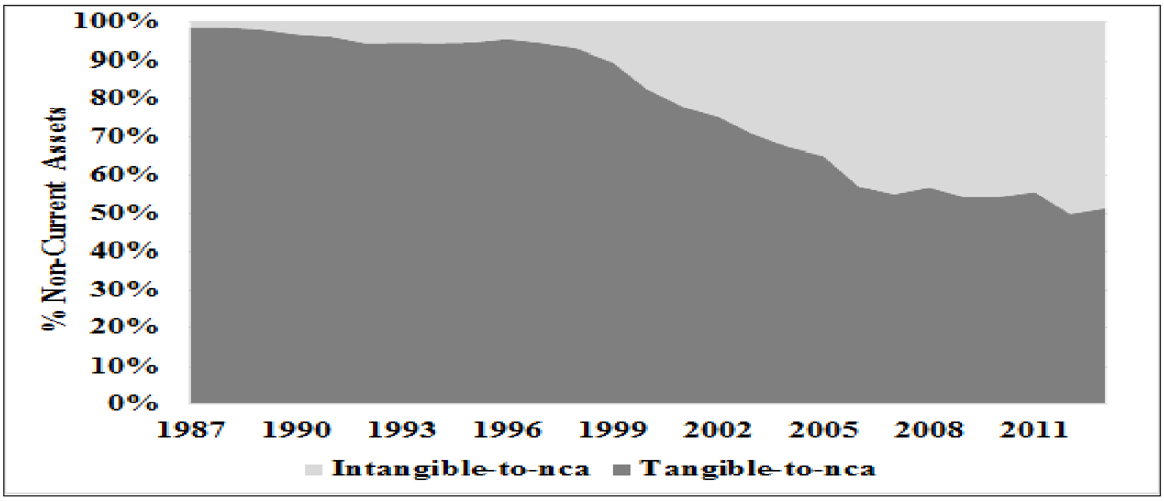
Appendix 5.B Tangible and intangible assets

ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1th and 99th percentiles. The data was drawn from Worldscope through Datastream.

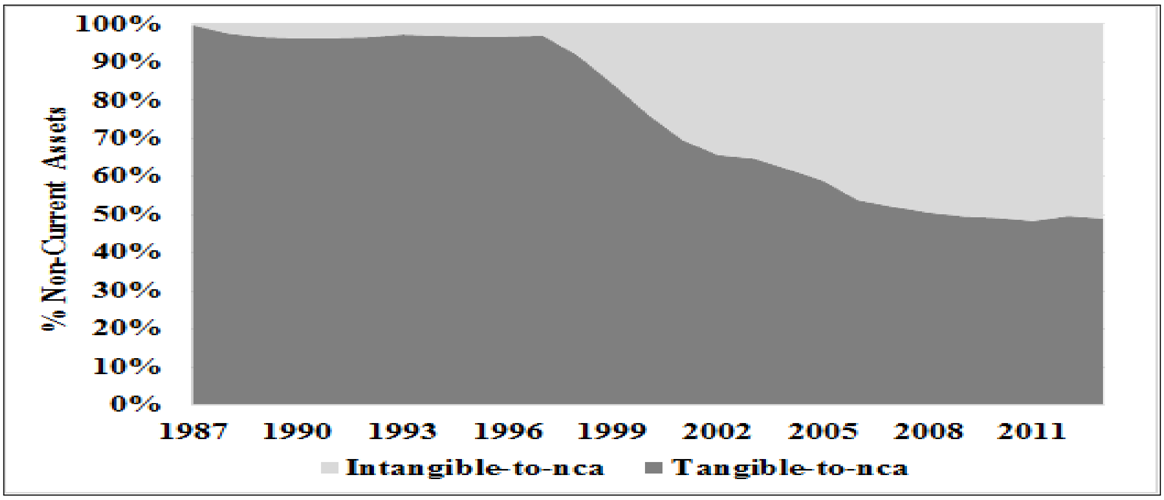
(a) ALL



(b) NIN

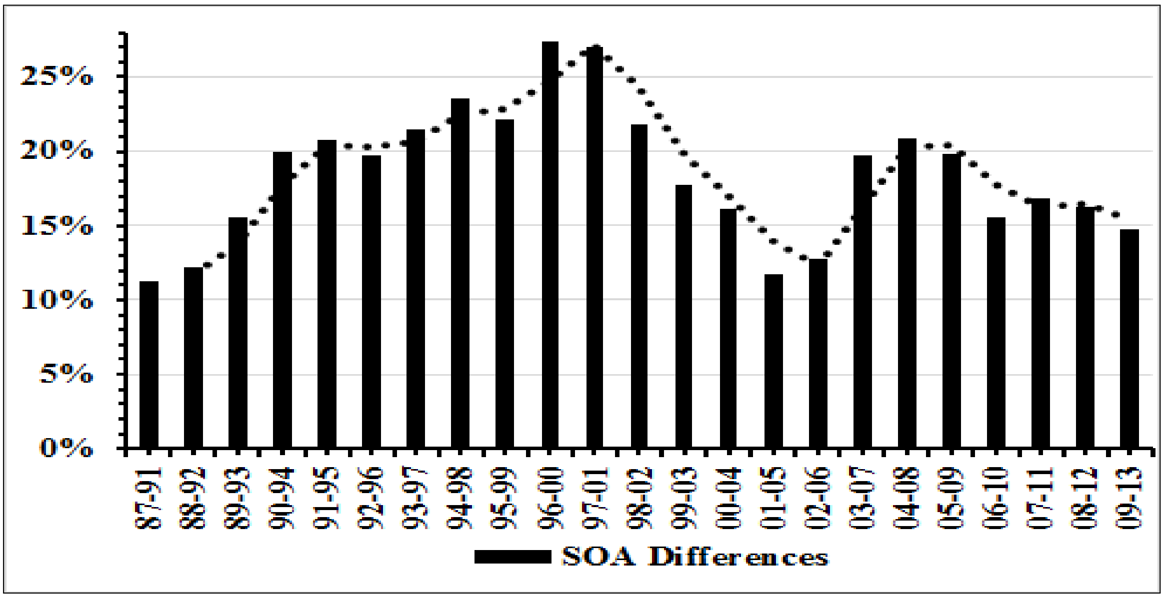


(c) INN



Appendix 5.C Differences in speed of adjustment

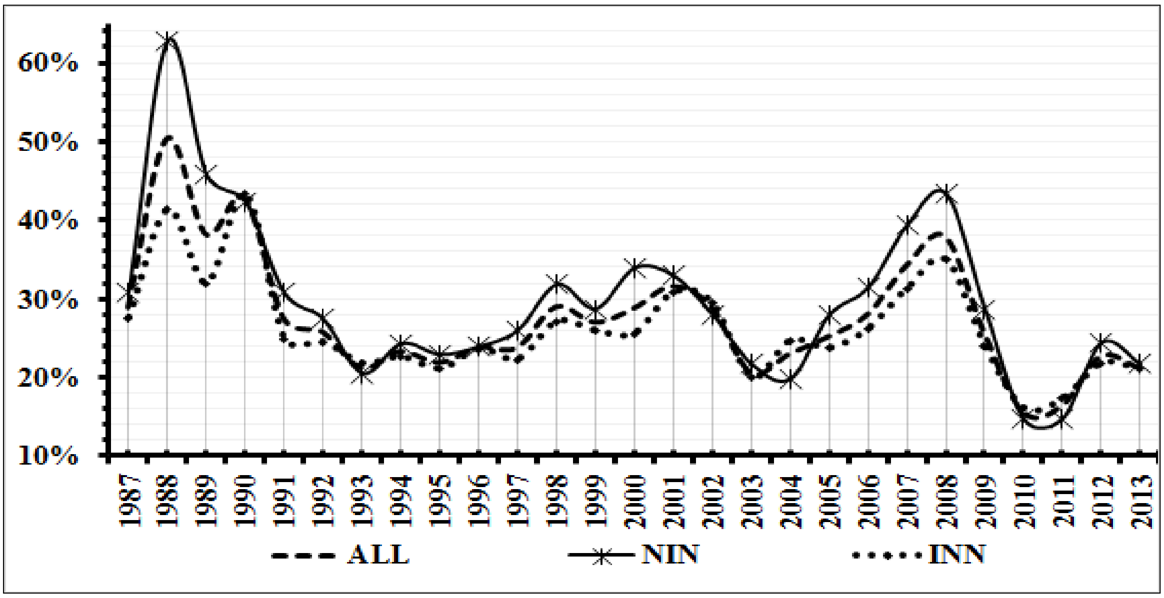
The figure presents the differences in the speed of adjustment between innovative (INN) and non-innovative (NIN) firms. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1$^{\text{th}}$ and 99$^{\text{th}}$ percentiles. The data is drawn from Worldscope through Datastream.



Appendix 5.D Evolution of target leverage

Panel A plots the mean target leverage. Panel B presents number of observations (N), mean, median, standard deviation (Stdev), 25th, 75th percentiles and the differences in target leverage (L^*_{it}) between innovative (INN) and non-innovative (NIN) firms. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream.

Panel A: Target leverage



Panel B: Descriptive statistics of target leverage

Group	N	Mean	SE	Stdev	[95% Conf. Interval]	
ALL	8,396	0.289	0.003	0.256	0.283	0.294
NIN	3,304	0.308	0.005	0.279	0.298	0.317
INN	5,092	0.276	0.003	0.239	0.270	0.283
Diff (NIN-INN)		0.031			0.020	0.042
p-value		(0.000)				

Appendix 5.E Time variations in speed of adjustment

The table presents estimation results of Equations (5.3) and (5.5) that relate change in book leverage to deviation of actual leverage from target leverage. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3. All variables used are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. All equations are estimated by OLS, and all regressions include industrial and time dummies (not reported). Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	Symmetric adjustments			Asymmetric adjustments			
Panel A: ALL							
Period	Dev_{it}	N	$Adj.R^2$	Dev_{it}^{Below}	Dev_{it}^{Above}	N	$Adj.R^2$
1987-1990	0.288*** (0.021)	744	0.30	0.270*** (0.030)	0.333*** (0.055)	744	0.30
1991-1995	0.291*** (0.014)	2156	0.30	0.219*** (0.022)	0.368*** (0.027)	2156	0.31
1996-2000	0.315*** (0.022)	1742	0.26	0.245*** (0.032)	0.431*** (0.041)	1742	0.27
2001-2005	0.285*** (0.019)	1236	0.29	0.232*** (0.030)	0.346*** (0.038)	1236	0.30
2006-2010	0.309*** (0.020)	1124	0.36	0.253*** (0.036)	0.380*** (0.030)	1124	0.37
2011-2013	0.317*** (0.026)	577	0.38	0.280*** (0.044)	0.358*** (0.045)	577	0.38
1987-2013	0.297*** (0.008)	7579	0.31	0.242*** (0.013)	0.372*** (0.015)	7579	0.31
Panel B: NIN							
1987-1990	0.274*** (0.028)	306	0.36	0.241*** (0.040)	0.360*** (0.082)	306	0.36
1991-1995	0.231*** (0.016)	922	0.28	0.191*** (0.026)	0.280*** (0.031)	922	0.29
1996-2000	0.209*** (0.023)	691	0.19	0.160*** (0.033)	0.322*** (0.042)	691	0.20
2001-2005	0.242*** (0.024)	434	0.35	0.217*** (0.042)	0.276*** (0.047)	434	0.35
2006-2010	0.245*** (0.024)	394	0.39	0.231*** (0.046)	0.269*** (0.037)	394	0.39
2011-2013	0.267*** (0.034)	198	0.42	0.274*** (0.055)	0.259*** (0.067)	198	0.41
1987-2013	0.236*** (0.009)	2945	0.31	0.207*** (0.015)	0.282*** (0.009)	2945	0.31
Panel C: INN							
1987-1990	0.343*** (0.036)	438	0.25	0.370*** (0.060)	0.288*** (0.064)	438	0.25
1991-1995	0.432*** (0.024)	1234	0.37	0.313*** (0.038)	0.530*** (0.039)	1234	0.38
1996-2000	0.480*** (0.032)	1051	0.36	0.494*** (0.054)	0.466*** (0.063)	1051	0.36
2001-2005	0.352*** (0.034)	802	0.29	0.292*** (0.055)	0.401*** (0.058)	802	0.29
2006-2010	0.416*** (0.028)	730	0.39	0.347*** (0.053)	0.475*** (0.043)	730	0.39
2011-2013	0.450*** (0.051)	379	0.41	0.375*** (0.097)	0.533*** (0.075)	379	0.42
1987-2013	0.407*** (0.013)	4634	0.34	0.355*** (0.023)	0.459*** (0.024)	4634	0.34

Appendix 5.F Net-debt adjustments: One-step approach

The table presents estimation results of Equation (5.1) that relates net-debt to lagged net-debt and lagged firm characteristics (research and development (R&D), capital expenditure (Capex), growth, tangible assets intangible assets, size, profit, non-debt tax shield, and volatility). ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. The results are estimated by system GMM. The table reports the *J statistic* which is a test of the over identifying restrictions, and the *J statistic* is asymptotically distributed as chi-squared under the null of instrument validity, and the test of second-order autocorrelation (*m2*) in the first differenced residuals. Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Variables	ALL	NIN	INN	NIN	INN	Diff (p-value)
NDA$_{it-1}$	0.683***	0.778***	0.579***	0.801***	0.586***	(0.002)
	(0.036)	(0.059)	(0.045)	(0.057)	(0.041)	
R&D	-0.198***		-0.226***		-0.210***	(0.001)
	(0.064)		(0.069)		(0.061)	
Capex	0.165***	0.216***	0.063	0.235***	0.059	(0.038)
	(0.045)	(0.069)	(0.059)	(0.064)	(0.058)	
Growth	-0.004*	-0.007**	-0.002	-0.005	-0.002	(0.507)
	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	
Tangible	0.210***	0.114***	0.305***	0.120***	0.334***	(0.000)
	(0.023)	(0.028)	(0.049)	(0.024)	(0.038)	
Intangible	0.204***	0.112***	0.299***	0.124***	0.306***	(0.000)
	(0.023)	(0.030)	(0.036)	(0.027)	(0.032)	
Size	0.002**	0.002	0.000	0.004***	-0.001	(0.000)
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	
Profit	-0.222***	-0.262***	-0.191***	-0.262***	-0.188***	(0.043)
	(0.022)	(0.030)	(0.027)	(0.028)	(0.023)	
NDTS	-0.373***	-0.228*	-0.297**	-0.300**	-0.370***	(0.647)
	(0.085)	(0.123)	(0.129)	(0.119)	(0.106)	
Volatility	-0.228***	-0.202**	-0.249***	-0.201***	-0.243***	(0.596)
	(0.036)	(0.085)	(0.032)	(0.073)	(0.032)	
Constant	-0.051**	-0.041	-0.026	-0.056**		
	(0.021)	(0.052)	(0.068)	(0.026)		
SOA (λ)	0.317	0.222	0.421	0.199	0.414	
N	7579	2945	4634	7579		
m2	-0.596	-0.235	-0.675	-0.655		
p-value	(0.551)	(0.814)	(0.513)	(0.513)		
J	68.815	72.430	67.967	140.283		
p-value	(0.518)	(0.398)	(0.547)	(0.477)		

Appendix 5.G Net-debt adjustments: Two-step approach

The table presents estimation results of Equation (5.3) that relates change in book net-debt to deviation of actual net-debt from target leverage. RDD is a dummy variable taking the value of one for innovative firms and zero otherwise. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream. All regressions include firm fixed effects and time dummies (not reported). Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Panel A: Symmetric net-debt adjustments

	ALL	NIN	INN	ALL
Dev_{it}	0.423***	0.371***	0.481***	0.360***
	(0.015)	(0.022)	(0.021)	(0.021)
$Dev_{it} \times RDD$				0.126***
				(0.028)
N	7579	2945	4634	7579
$Adj.R^2$	0.296	0.297	0.307	0.302

Panel B: Asymmetric net-debt adjustments

	ALL	NIN	INN	ALL
Dev_{it}^{Above}	0.486***	0.415***	0.544***	0.402***
	(0.031)	(0.036)	(0.048)	(0.036)
$Dev_{it}^{Above} \times RDD$				0.146**
				(0.058)
Dev_{it}^{Below}	0.386***	0.348***	0.440***	0.337***
	(0.022)	(0.030)	(0.033)	(0.030)
$Dev_{it}^{Below} \times RDD$				0.108**
				(0.043)
N	7579	2945	4632	7577
$Adj.R^2$	817	0.286	0.313	0.301

Appendix 5.H Speed of adjustment: DFP

The table presents estimation results of Equations (5.1) and (5.2) that relate leverage to lagged leverage and lagged firm characteristics (research and development (R&D), capital expenditure (Capex), growth, tangible assets intangible assets, size, profit, non-debt tax shield, and volatility). Leverage is defined as total debt, net-debt and long-term debt. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. The results are estimated an unbalanced dynamic panel data with a fractional dependent variable (DPF) estimator (see; Drobetz et al., 2015; Elsas and Florysiak, 2011, 2013). The table reports log likelihood ratio (*LM*). Standard errors are reported in parenthesis. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	TDA				NDA				LTDA			
Variables	ALL	NIN	INN	Diff (p-value)	ALL	NIN	INN	Diff (p-value)	ALL	NIN	INN	Diff (p-value)
L_{it-1}	0.707***	0.744***	0.689***	(0.001)	0.601***	0.647***	0.576***	(0.000)	0.709***	0.751***	0.683***	(0.000)
	(0.012)	(0.015)	(0.013)		(0.012)	(0.017)	(0.014)		(0.013)	(0.016)	(0.014)	
R&D	-0.163***		-0.159***	(0.000)	-0.237***		-0.235***	(0.000)	-0.058***		-0.059***	(0.010)
	(0.026)		(0.027)		(0.058)		(0.059)		(0.022)		(0.023)	
Capex	0.157***	0.208***	0.094***	(0.008)	0.223***	0.262***	0.180***	(0.162)	0.100***	0.126***	0.062**	(0.093)
	(0.022)	(0.029)	(0.033)		(0.030)	(0.038)	(0.045)		(0.020)	(0.026)	(0.030)	
Tangible	0.051***	-0.001	0.000	(0.028)	0.166***	-0.007**	-0.001	(0.000)	0.052***	-0.001	0.000	(0.025)
	(0.008)	(0.002)	(0.001)		(0.014)	(0.003)	(0.002)		(0.007)	(0.001)	(0.001)	
Intangible	0.057***	0.034***	0.067***	(0.132)	0.183***	0.119***	0.213***	(0.000)	0.060***	0.037***	0.064***	(0.007)
	(0.009)	(0.011)	(0.012)		(0.013)	(0.016)	(0.018)		(0.007)	(0.009)	(0.010)	
Growth	-0.001	0.043***	0.064***	(0.621)	-0.003	0.141***	0.213***	(0.081)	-0.001	0.041***	0.072***	(0.391)
	(0.001)	(0.012)	(0.010)		(0.002)	(0.018)	(0.016)		(0.001)	(0.010)	(0.009)	
Size	0.006***	0.006***	0.005***	(0.184)	0.004***	0.006***	0.002**	(0.000)	0.005***	0.006***	0.005***	(0.032)
	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)	
Profit	-0.168***	-0.198***	-0.146***	(0.002)	-0.212***	-0.232***	-0.192***	(0.000)	-0.066***	-0.080***	-0.056***	(0.098)
	(0.008)	(0.013)	(0.010)		(0.012)	(0.018)	(0.016)		(0.007)	(0.012)	(0.009)	
NDTS	-0.207***	-0.235***	-0.150**	(0.311)	-0.323***	-0.325***	-0.290***	(0.000)	-0.160***	-0.169***	-0.124**	(0.523)
	(0.044)	(0.063)	(0.059)		(0.064)	(0.088)	(0.088)		(0.038)	(0.054)	(0.050)	
Volatility	-0.092***	-0.117***	-0.079***	(0.285)	-0.143***	-0.146***	-0.135***	(0.000)	-0.041**	-0.068***	-0.023	(0.159)
	(0.018)	(0.028)	(0.023)		(0.028)	(0.039)	(0.038)		(0.016)	(0.025)	(0.021)	
Constant	-0.037***	-0.038***			-0.103***	-0.105***			-0.055***	-0.058***		
	(0.012)	(0.013)			(0.020)	(0.020)			(0.010)	(0.010)		
SOA (λ)	0.293	0.256	0.311		0.399	0.353	0.424		0.291	0.249	0.317	
N	7579	7579			7579	7579			7579	7579		
LM	10130.282	10146.117			5565.816	5588.176			10811.299	10828.680		
p-value	(0.000)	(0.000)			(0.000)	(0.000)			(0.000)	(0.000)		

Appendix 5.I Sensitivity of leverage adjustments to macroeconomic shocks

The table presents estimation results of Equation 5.11 that relates the speed of adjustment to macroeconomic variables.

$$\Psi_t = \eta_0 + \vartheta Z_{t-1} + \mu_t \tag{5.11}$$

where $\boldsymbol{\Psi_t}$ is the vector of the speed of adjustment obtained from estimations of Equation 5.3 in 5 year rolling windows over the sample period, η_0 is a constant, $\boldsymbol{\vartheta}$ is a vector of parameter coefficients, $\mathbf{Z_{t\text{-}1}}$ is a vector of proxies for macroeconomic shocks described below, and μ_t is the error term. $\mathbf{Z_{t\text{-}1}}$ includes averages changes in macroeconomic variables in Panel A and averages proxies of macroeconomic shocks estimates from an autoregressive model of macroeconomic variables in Panel B. The macroeconomic variables include Gross Domestic Product growth (GDPg), changes in real interest rate (ΔIR) and the inflation rate (Inflation). ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3. The data is drawn from Worldscope through Datastream. The results are estimated by OLS. Standard errors reported in parenthesis are based on Newey and West (1987), which account for heteroskedasticity and autocorrelation. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	Panel A: Simple averages			Panel B: Autoregressive averages		
	ALL	NIN	INN	ALL	NIN	INN
GDPg	-0.886**	-0.958**	-1.726**	-1.392**	-0.837*	-4.356***
	(0.339)	(0.418)	(0.667)	(0.492)	(0.461)	(1.233)
ΔIR	2.449***	1.033	6.815***	2.286**	-0.087	7.461***
	(0.659)	(0.797)	(1.735)	(0.919)	(0.679)	(1.961)
Inflation	-0.539**	0.338	-1.186**	-1.472**	2.388***	-7.106***
	(0.237)	(0.368)	(0.501)	(0.619)	(0.443)	(1.266)
Constant	0.345***	0.256***	0.516***	0.305***	0.240***	0.429***
	(0.013)	(0.018)	(0.018)	(0.003)	(0.003)	(0.006)
N	23	23	23	23	23	23
$Adj.R^2$	0.420	0.471	0.431	0.307	0.620	0.642

Chapter 6

Trade Credit: The Case of Innovative versus Non-Innovative Firms

6.1 Summary

Using a sample of 817 non-financial firms in the UK, the analysis presented in this chapter examines the determinants of trade credit, the time variations in the sensitivity of trade credit to cash and short-term debt, and trade credit adjustments. Comparisons between innovative and non-innovative firms are made throughout. Although trade credit has decreased in the UK over the period 1987-2013, firms in the UK remain net suppliers of trade credit. Evidence is also presented suggesting that innovative firms use (give) less (more) trade credit than non-innovative firms. Further, evidence is also presented that the trade-off between short term debt and trade credit, and between cash and trade credit vary over time (switching from a compliment to a substitute or vice versa) and across innovative and non-innovative firms. There is also evidence that firms adjust towards a target credit level at a slow-to-moderate speed, which would be consistent with the existence of adjustment costs. Innovative firms consistently adjust faster than non-innovative firms which suggests that they benefit more from re-balancing trade credit towards the target. Overall, the results show that there is significant heterogeneity in trade credit polices and asymmetry in trade credit adjustments conditional on investment types.

6.2 Introduction

Trade credit is an important form of short-term financing, especially for financially constrained firms and during periods characterised by contractions in bank lending.[1] Despite this importance, there are relatively few comprehensive studies on trade credit.[2] Several questions on trade credit remain unanswered. What determines

[1] Rajan and Zingales (1995) report that in 1991 trade credit represented 17.8% of US firms' assets, 22% in the UK and over 25% for other countries. Demirguc-Kunt and Maksimovic (2001) report that trade credit accounted for 25% of firms' total assets in France, Germany, and Italy. Aktas et al. (2012) report that trade credit has averaged between 10% and 15% of total assets in the US. A study of small business in the US by Petersen and Rajan (1997) report that trade credit is the single most important component of short-term financing as it accounts for 17% of current assets. Wu et al. (2012) report similar results in China, with trade credit between 11% and 15% of total assets.

[2] Petersen and Rajan (1997) attribute the few studies on trade credit to the lack of information. Some databases do not report variables on trade credit, and when reported, it often lacks detail to facilitate testing of theoretical propositions.

trade credit?[3] Is trade credit a substitute or a compliment to traditional sources of short-term financing?[4] The literature has also overlooked the heterogeneity in trade credit arising from differences in firm characteristics, in particular, the type of investment that firms undertake. Yet, investment types have significant effects on operating risks and capital structure, which will also affect decisions on whether to give or take trade credit.[5]

The analysis in this chapter fills this gap in the literature by investigating the determinants of trade credit, the relationship between trade credit and other forms of short-term financing, dynamic adjustments in trade credit, and the differences in trade credit policies between innovative and non-innovative firms. This chapter contributes to the ongoing debate on whether trade credit is a substitute or a complement to other forms of financing by examining the time variation of the relationship between trade credit and other short-term liabilities, and between trade credit and cash.[6] Yang (2011b) reports that the relationship between bank credit and trade credit changes with the monetary policy in the US from 1986 to 2006. They report that the substitution (complimentary) effect dominates in periods of tight (loose)

[3]Empirical evidence on trade credit is rather mixed and more confined to the US which limits its generalisability to other economies that have different legal, institutional and macroeconomic environments. Furthermore, it has not been fully established why firms continue to use trade credit as a form of financing even though it is relatively more expensive than other forms of short-term financing. For example, Lin and Chou (2015) estimate that the implied interest rate on a "1/10 net 30" trade credit contract to be around 18.25% in China over the period 2006-2012, while Ng et al. (1999) report implied costs above 42% from a survey of credit managers of 2,538 firms in the US. A model of Wilner (2000) also estimate relatively high implied interest rates on trade credit contracts. Similarly, Biais and Gollier (1997) and Kling et al. (2014) report that there exists a substitution effect between trade credit and traditional forms of financing, with mostly the former being substituted for the latter, as trade credit is a relatively more expensive form of short-term financing. Despite the theoretical predictions that trade credit is only used after all other forms of financing have been exhausted (see, Petersen and Rajan, 1994, 1995), Wilner (2000) reports that even financially unconstrained firms which have the ability to obtain better credit terms from banks still extensively use trade credit.

[4]The short term nature and high implicit interest on trade credit (Ng et al., 1999; Wilner, 2000), should all discourage reliance trade credit, with firms substituting trade credit for other forms of financing. However, existence of financial constraints which preclude financially weak firms from access corporate debt markets should result in trade credit being a compliment rather than a substitute to other forms of short-term financing. Cuñat (2007) and Petersen and Rajan (1997) report that suppliers with comparative advantages in evaluating their customers may borrow from lending institutions at relatively better terms than their customers, and in turn give credit to financially constrained customers.

[5]Krainer (2014) develops a model which shows that managers use capital structure to manage operating risk and ensure that it is within the thresholds commensurate with the shareholders' risk tolerance.

[6]Results on the relationship between trade credit and short-term debt are rather mixed (see, inter alia, Ferrando and Mulier, 2013; Giannetti et al., 2011; Love et al., 2007; Yang, 2011b).

monetary policy. Similarly, Meltzer (1960) reports that the monetary cycle has a significant effect on the relationship between trade credit and short-term debt. Also, the role of trade credit in firm financing changes in the presence of financial constraints.[7] This leads to two opposing empirically testable hypothesis on trade credit. First, firms subject to binding credit constrains often use more trade credit which results in the complementary effect (a positive relationship is predicted) predominating the substitution effect. When comparing innovative and non-innovative firms, the complementary effect should be significantly higher for innovative firms that are more likely to face binding credit constraints.[8] This comparison allows for an analysis of how the relationship between trade credit and other forms of short-term financing differs conditional on investment types and across firms.

Second, the presence of innovative investments (with long investment horizons) should discourage the use of trade credit as it is a relatively expensive form of short-term financing (see, inter alia, Lin and Chou, 2015; Petersen and Rajan, 1994, 1995). Further, this short-term nature of trade credit financing reduces flexibility, which is critical for survival in competitive innovative markets (O'Brien, 2003). Firms subject to high operating risk should adopt conservative financing structures (see Krainer, 2014), hence, rely less on trade credit financing. This should result in a significant negative relationship between short-term debt and trade credit (accounts payable) for innovative firms. When examining trade credit extended (accounts receivable), the specialised nature of the investments and products of innovative firms may necessitate the provision of trade credit as a form of warranty on product quality. According to Antràs and Foley (2011), Lee and Stowe (1993) and Long et al. (1993),

[7] Borisova and Brown (2013) report that R&D subject firms to binding financial constraints. Petersen and Rajan (1994, 1995, 1997) and Wilner (1997) also report that financially constrained firms rely more on trade credit than unconstrained firms. Similarly, Huyghebaert (2006) report that start-ups use more trade credit as consistent with the existence of binding financial constraints. Following on these results, financially constrained firms may view trade credit as a complement to other forms of financing while unconstrained firms are likely to use short-term debt as a substitute to trade credit.

[8] Consistent with this prediction, a model of Wilner (2000) posits that financially constrained firms are more willing to pay higher implied rates in trade credit contracts as they anticipate larger renegotiation concessions from long-term or more dependent suppliers in case of bankruptcy. A model of Fabbri and Menichini (2010) also predicts that financially constrained firms take trade credit to exploit the supplier' s advantage in liquidating repossessed assets. Further, suppliers tend to grant more concessions in case of financial distress than would be granted by lenders in competitive credit markets (see, Evans, 1998; Wilner, 2000).

trade credit is used as a form of guarantee on the quality of the products sold as it allows the buyer to try the product before making a payment. This should result in a positive relationship between trade credit extended and short-term debt, which will be significantly higher for innovative firms than non-innovative firms.[9] This chapter empirically tests these predictions by drawing comparisons between innovative and non-innovative firms over time.

Further, prior studies have overlooked the dynamic nature of trade credit policies.[10] This chapter examines dynamic adjustments in trade credit as the decision to extend (use) trade credit is influenced by both past and future conditions. The existence of adjustment costs result in slow speeds of adjustment as reported in the literature on capital structure.[11] A slow speed of adjustment (high persistence) implies greater reliance on trade credit, while a high speed of adjustment (low persistence) indicates less reliance on trade credit.[12] The main prediction from this analysis is that innovative firms should have a higher speed of adjustment as they benefit more from actively adjusting towards the target than non-innovative firms.[13] The focus on the differences between innovative and non-innovative firms is motivated by the need to understand the implications of the shifts in the economy from predominately manufacturing industries towards service and technology based industries on corporate decisions.[14]

[9] However, Long et al. (1993) highlight an opposing proposition that more reputable suppliers need not give trade credit as their reputation dispenses with the need to provide a product warranty (in the form of trade credit).

[10] For studies that examine the determinants of trade credit, see, Dass et al. (2014), Lin and Chou (2015), Love et al. (2007), Klapper et al. (2012), Mizen (2008), Wu et al. (2012) and Yang (2011a).

[11] Models on the dynamic trade-off theory of capital structure by Fischer et al. (1989), Goldstein et al. (2001), Hennessy and Whited (2005) and Strebulaev (2007) attribute the slow adjustment to the existence of adjustment costs, with managers only adjusting when benefits outweigh costs of adjusting capital structure. Similarly, Faulkender et al. (2012), Leary and Roberts (2005) and Strebulaev (2007) report that adjustment costs are the major impediments to the attainment of the the target capital structure.

[12] The level of persistence in trade credit can be used as an indicator of financial constraints and also for testing whether firms actively adjust towards the target A low level of persistence in trade credit indicates that firms more actively re-balance towards the target, while a high persistence results in a slow or insignificant speed of adjustment. Firms with high persistence take or give more on trade credit over time.

[13] Firms that have intangible investments and subject to information asymmetry problems face high bankruptcy costs (see, Myers, 1984; Myers and Majluf, 1984), which implies that they face higher costs of deviating from the target.

[14] Buera and Kaboski (2012) highlight that the literature has overlooked the effects of the significant transition of economies from mostly manufacturing sectors towards technological and service

Using a sample of 817 firms (8 396 firm-year observations) over the period 1987 to 2013, the analyses in this chapter show that there are secular decreases in trade credit. Accounts payable (accounts receivable) gradually decreased from a peak of 17.4% (26.8%) in 1996 to a low of 9.4% (14.5%) in 2009. In accounts receivable (AR), this decrease is relatively more pronounced for non-innovative firms from 2006 to 2011, which extend progressively less trade credit than innovative firms. The relatively higher trade credit extended (AR) by innovative firms is rather inconsistent with the proposition that firms that invest in innovation face binding financial constraints that may reduce their ability to extend credit to their customers.[15] This high trade credit extended by innovative firms is consistent with the proposition that suppliers of specialised products have comparative advantages in liquidating goods repossessed from their customers in case of default (see, inter alia, Fabbri and Menichini, 2010; Petersen and Rajan, 1997). These comparative advantages enable suppliers to offer more credit at better terms than institutional lenders, who have to charge a premium in the presence of information asymmetry. Similar decreases as those on trade credit (accounts payable and accounts receivable) are also observed on net trade credit, with innovative firms consistently extending more credit than non-innovative firms. Despite these decreases in trade credit, it remains an important form of financing (averaging 13.4% for accounts payable and 22.8% for accounts receivable), with listed firms in the UK being net trade credit suppliers throughout the sample period.

The analysis in this chapter also presents evidence that the role of trade credit in

based sectors on corporate decisions. Borisova and Brown (2013) also report marked increases in R&D for young US firms to levels that are four times that of capital expenditure, while R&D is twice as high as capital expenditure for mature firms over the period 1980-2008 . Similarly, Fama and French (2004, 2005) report an influx of new listings by young and high growth firms in the US from 1980 to 2001.

[15] Studies in the US by Brown and Petersen (2014) (2004-2010) and Borisova and Brown (2013) (1980-2008) report that R&D subjects firms to binding financial constraints. Similarly, Petersen and Rajan (1997) report that US firms that are subject to binding financial constraints over the period 1970 to 1987 extend less trade credit. However, using a sample of 17 European countries (including the UK, France and Germany) over the period 1995-2007, Brown et al. (2012) report very high R&D intensities for young publicly trade firms in the UK and Sweden. They argue that going public reduces the effects of financial constraints which enables firms to increase investments. Bernstein (2015) also reports that going public enables firms to attract human capital and increases flexibility in their corporate strategies.

firm financing in the UK differs conditional on whether or not a firm invests in R&D. Short-term debt and accounts payable are mostly substitutes, while short-term debt and accounts receivable are compliments. The negative relationship between accounts payable and other short-term liabilities is consistent with the substitution hypothesis. This posits that firms with access to other forms of financing rely less on the relatively expensive trade credit financing. Comparisons between non-innovative and innovative firms show that the negative effect of other short-term liabilities is significantly higher for non-innovative firms than for innovative firms. This result suggests that non-innovative firms can more readily reduce trade credit than innovative firms as they face less binding credit constraints. Cash has a negative effect on trade credit, except for its insignificant and positive effect on accounts payable of non-innovative firms. This positive relationship between cash and trade credit suggests that non-innovative firms do not use cash to reduce trade credit even though it is considered to be an expensive form of short-term financing. The significantly high negative effect of cash on trade credit for innovative firms suggests that innovative firms with more liquid assets use less trade credit. This is consistent with the proposition that trade credit is an expensive form of financing (see, Lin and Chou, 2015; Ng et al., 1999) and that its short-term nature tend to restrict strategic flexibility.[16]

Further, the results show that other short-term liabilities have a significant positive effect on trade credit, while cash has a negative effect. This suggests that firms with access to other forms of short-term financing extend more trade credit (accounts receivable).[17] The results also show that the positive relationship between trade credit and other short-term liabilities is only significant for innovative firm. Accordingly, evidence is presented that it is mostly innovative firms that use their access to other forms of short term debt to increase the trade credit they extend to their customers. This is consistent with the trade credit proposition that trade credit is used to allevi-

[16] O'Brien (2003) reports that strategic flexibility is important for survival in competitive markets for innovation. This implies that firms in innovative markets will use less trade credit as it is difficult to roll-over. Similarly, Kahl et al. (2015) report that trade credit is often difficult to get when needed most in tight credit markets, and when credit quality deteriorates.

[17] Cuñat (2007) and Petersen and Rajan (1997) also report that firms in the US with access to bank loans tend to extend more trade credit.

ate imperfections in the product markets, but reveals that this role is more prominent (as shown by the results) for firms that undertake innovative investments. The significantly higher negative relationship between trade credit extended and cash for innovative firms is consistent with the proposition that cash is more valuable for firms with R&D expenditure as they use it to smooth transitory finance shocks.[18] Similar results are also observed on net trade credit. This evidence suggests that the nature of investments undertaken by firms is important to the decision of granting or taking trade credit.[19] These results are robust to different estimation methods and definitions of trade credit.

The results from the analyses in this chapter also show that there are significant time variation and asymmetry in the relationship between trade credit and other forms of short-term financing (short-term debt and cash), and that firms have a target trade credit level. Although the relationship between trade credit and other short-term liabilities is significant and consistently negative, it is rather weak for innovative firms that are more likely to face binding financial constraints. The results also show that the relationship between trade credit (accounts payable) and cash, between trade credit extended (accounts receivable) and other short-term liabilities, and between trade credit extended and cash change in sign and significance. These significant time and cross-sectional variations in the relationship between short-term debt and trade credit could explain the mixed results in the literature.[20] The changes occur mostly for non-innovative firms that face less binding credit constraints and have more flexibility in choosing the form of financing.

Finally, an examination of trade credit adjustments show that UK firms adjust at

[18] Brown and Petersen (2011) report that firms in the US use cash holdings to smooth their R&D expenditure. This increases the incentive to hoard cash for innovative firms as they may face binding financial constraints (see, Brown et al., 2009).

[19] The heterogeneity between innovative and non-innovative firms on trade credit is consistent with several studies reporting significant linkages between the product market and capital structure (see, inter alia, Campello, 2003; Hackbarth et al., 2012; Istaitieh and Rodríguez-Fernández, 2006; Kovenock and Phillips, 1995; Rauh and Sufi, 2012; Spence, 1985).

[20] For example, Giannetti et al. (2011) report a positive relationship between trade credit and bank loans, while Yang (2011b) report that the relationship is positive in a loose monetary regime and negative in tight monetary regime.

a slow-to-moderate speed (20.1%) as is consistent with the existence of adjustment costs. Comparisons of trade credit adjustments show significant asymmetries in trade credit (accounts payable) adjustments as innovative firms adjust at a speed of 23.7%, while non-innovative firms adjust at a speed of 16.2%. There are similar and significant differences in the speed of adjustment on trade credit extended (accounts receivable). Non-innovative firms adjust trade credit extended at a speed of 12.9%, which is 9.4% lower than that of innovative firms. This relatively high speed of adjustment on trade credit for innovative firms than non-innovative firms is consistent with results on leverage adjustments in Chapter 5. These differences in adjustment speeds of trade credit suggest that innovative firms benefit more from adjusting towards the target than non-innovative firms. Further, firms that invest in innovation face high bankruptcy costs, which increase the costs of deviating from the target trade credit level. These results further show that there is significant heterogeneity in trade credit policies between innovative and non-innovative firms.

The analysis in this chapter relates to Petersen and Rajan (1997) who examine the factors affecting trade credit policies of small businesses in the US over the period 1988-1989. They report that financially constrained firms use more trade credit, with suppliers prepared to lend to these firms given their comparative advantages in accessing information and liquidating repossessed assets in case of default. In addition to the factors studied by Petersen and Rajan (1997), the analysis in this chapter investigates the role of the different forms of investment on trade credit. One rationale is that the investment types subject firms to different operating risks, hence are financed through heterogeneous financing means (see, inter alia, Brown and Petersen, 2011; Brown et al., 2012; Hall, 2009; Hall and Lerner, 2010). The results in this chapter are inconsistent with Petersen and Rajan (1997) as they show that supposedly constrained firms (innovative firms) give (use) more (less) trade credit. It is consistent, however, with the informational advantage proposition that suppliers are better positioned to assess the credit quality of their customers. The analysis presented in this chapter also relates to a group of studies on the relationship between trade credit and short-term debt (see, inter alia, Guariglia and Mateut, 2013;

Bougheas et al., 2009; Love et al., 2007; Wu et al., 2012). This analysis contributes to these studies by investigating the time variation in trade credit, and whether the substitution or the complementary effect dominates over time. Further, the analysis also adds to the literature by examining trade credit adjustments which have been overlooked by previous studies. The results show that firms slowly adjust towards the target trade credit level as is consistent with the existence of adjustment costs and the focus on actively managing financing sources in order to maximise firm value.

The rest of this chapter is organised as follows: Section 6.3 presents the methodology used, Section 6.4 discusses the the empirical results, Section 6.5 presents robustness tests, and Section 6.6 concludes.

6.3 Methodology

Four separate panel data models are used to investigate the determinants of trade credit (accounts payable and accounts receivable) and dynamic adjustments in trade credit. The first model is;

$$TC_{it} = \beta_0 + \boldsymbol{\beta}\mathbf{X}_{it-1} + \eta_i + \eta_t + \epsilon_{it} \tag{6.1}$$

where TC_{it} is the ratio of accounts payable to total assets (AP) or accounts receivable to total assets (AR) for firm i at time t, β_0 is a constant, $\boldsymbol{\beta}$ is a vector of parameter coefficients, $\mathbf{X}_{it-1}$ is a vector of lagged firm specific factors (explained below), η_i is the firm specific effect, η_t represents time-specific effects and ϵ_{it} is an error term. $\mathbf{X}_{it-1}$ includes, short-term debt, cash, tangible assets, intangible assets, sales growth, size, profit, asset turnover and volatility.

In all other cases, the following version of Equation (6.1) is used to examine differences between innovative and non-innovative firms, and to estimate target trade credit:

$$TC_{it} = \gamma_0 + \boldsymbol{\theta}^{NIN}\mathbf{X}^{NIN}_{it-1} + \boldsymbol{\theta}^{INN}\mathbf{X}^{INN}_{it-1} + \zeta_i + \zeta_t + \mu_{it} \tag{6.2}$$

where γ_0 is a constant; $\boldsymbol{\theta}^{INN}$ and $\boldsymbol{\theta}^{NIN}$ are the sensitivities to firm-specific characteristics of innovative and non-innovative firms, respectively; ζ_i are firm-specific effects; ζ_t are time-specific effects; and μ_{it} is the error term. The focus of Equation (6.2) is on whether the coefficients differ between non-innovative (NIN) and innovative (INN) firms. Equation (6.2) is also used to compute the target trade credit. The target trade credit for innovative firms is computed as $\hat{\theta}^{INN}\mathbf{X}^{INN}_{it-1}$, and that for non-innovative firms as $\hat{\theta}^{NIN}\mathbf{X}^{NIN}_{it-1}$. These are then stacked as the overall firm estimate for the target trade credit TC^*_{it}.

The target trade credit (TC^*_{it}) computed above is used in this second step to examine whether firms in the UK adjust towards a target credit level as follows:

$$\Delta TC_{it} = TC_{it} - TC_{it-1} = \lambda(TC^*_{it} - TC_{it-1}) + \varepsilon_{it} \tag{6.3}$$

where ΔTC_{it}, is the change in trade credit from the previous year ($TC_{it} - TC_{it-1}$), λ is the measure of the speed of adjustment and ε_{it} is an error term. If $\lambda = 0$, then there is no adjustment; $\lambda = 1$ then there is full adjustment towards the target; and if $0 < \lambda < 1$, then there is partial adjustment.

To investigate differences in the speed of adjustment between innovative and non-innovative firms, Equation (6.3) is modified to include a dummy variable (*RDD*) that takes the value of one for firms that report R&D and zero otherwise:

$$\Delta TC_{it} = (\lambda_1 + \lambda_2 \times RDD)Dev_{it} + \varepsilon_{it} \tag{6.4}$$

where λ_1 is the measure of the speed of adjustment for non-innovative firms, λ_2 is the measure of the difference in the speed of adjustment between non-innovative (NIN) and innovative firms (INN) and $Dev_{it} = TC^*_{it} - TC_{it-1}$ is the deviation from target trade credit.

Equations (6.1) - (6.4) are estimated using OLS. Several studies on trade credit use a similar approach (e.g., Giannetti et al., 2011; Love et al., 2007; Klapper et al., 2012). OLS is used due to data limitations which prevent the use of system GMM techniques, but, where appropriate, results estimated using other techniques are presented for robustness.[21,22]

6.4 Empirical results

This section is organised as follows: Section 6.4.1 presents results on the effects of cash and other short-term liabilities on accounts payable, and the differential effects between innovative and non-innovative firms; Section 6.4.2 presents results on the effects of cash and other short-term liabilities on accounts receivable, and the differential effects between innovative and non-innovative firms; Section 6.4.3 presents results on the time varying effects of cash and other short-term liabilities on trade credit; and Section 6.4.4 presents results on trade credit adjustments.

6.4.1 Accounts payable, cash and short-term debt

Table 6.1 presents the estimating results of Equations (6.1) and (6.2) that relate accounts payable (AP) to firm specific factors. The second, third and fourth columns present the estimating results of Equation (6.1) separately for all firms (ALL), non-innovative firms (NIN) and innovative firms (INN), respectively. The fifth column (ALL) presents the estimating results of Equation (6.2) that allows for direct testing of the differences in the coefficients between non-innovative and innovative firms. All the estimated models include industry and time dummies.

The result in the second column shows a significant negative effect of other short-

[21]The system GMM estimation approach requires the use of lags as instruments for the endogenous variables, which greatly reduces the sample size. Further, the results obtained using system GMM fail the Hansen-Sargan test (J-test) of over-identifying restrictions, and the tests for the non-existence of first order (*m1*) and second order (*m2*) serial correlation in the differenced residuals.

[22]The other estimation techniques used for robustness are OLS with Newey-West standard errors (NEWEY), Fama and MacBeth (1973) (FM) procedure and the DPF estimator (see, Elsas and Florysiak, 2011, 2013) (DPF). According to Elsas and Florysiak (2011), the DPF estimator is a doubly-censored tobit estimator ([0,1]), which relies on a latent variable approach to explicitly account for the fractional nature of ratios. The DPF approach is implemented in this chapter using Stata *xttobit*. Drobetz et al. (2015) and Elsas and Florysiak (2011, 2013) use a similar approach.

Table 6.1 Accounts payable

The table presents the results of estimating Equations (6.1) and (6.2) that relate trade credit (AP or AR) to firm characteristics. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	ALL	NIN	INN	NIN	INN	Diff (*p*-value)
Ostliab	-0.071*** (0.013)	-0.134*** (0.021)	-0.026* (0.014)	-0.141*** (0.021)	-0.028* (0.015)	(0.000)
Cash	-0.044** (0.021)	0.063 (0.038)	-0.106*** (0.025)	0.047 (0.039)	-0.100*** (0.021)	(0.001)
Tangible	-0.057*** (0.017)	-0.031 (0.024)	-0.090*** (0.019)	-0.050** (0.021)	-0.074*** (0.017)	(0.323)
Intangible	-0.059*** (0.020)	-0.046 (0.031)	-0.087*** (0.023)	-0.050** (0.024)	-0.080*** (0.020)	(0.215)
Size	-0.002** (0.001)	-0.001 (0.002)	-0.003** (0.001)	-0.003** (0.002)	-0.002* (0.001)	(0.332)
Profit	-0.102*** (0.015)	-0.133*** (0.024)	-0.082*** (0.019)	-0.136*** (0.025)	-0.080*** (0.019)	(0.083)
AssetTurn	0.097*** (0.008)	0.112*** (0.008)	0.074*** (0.011)	0.109*** (0.007)	0.077*** (0.010)	(0.001)
Volatility	-0.04 (0.029)	-0.049 (0.051)	-0.023 (0.029)	-0.068 (0.059)	-0.013 (0.027)	(0.408)
Constant	0.094*** (0.022)	0.062* (0.034)	0.065** (0.031)	0.036 (0.023)		
N	7579	2945	4634	7579		
Adj.R^2	0.576	0.648	0.530	0.591		

term liabilities on accounts payable. This result is consistent with the substitution hypothesis that firms with access to other forms of financing (e.g., long-term debt) use less trade credit (e.g., Meltzer, 1960). However, Guariglia and Mateut (2013) report a complimentary effect between short-term debt and trade credit. The complimentary effect would suggest that firms use both short-term debt and trade credit even though trade credit is considered to be a relatively expensive form of financing according to Lin and Chou (2015) and Ng et al. (1999). Table 6.1, second column, shows that the coefficient on cash is negative and significant, which suggests that firms with better liquidity positions tend to reduce the other relatively expensive short-term sources of financing (such as trade credit). This is inconsistent with Bougheas et al. (2009) who report a positive relationship between cash and trade credit (accounts payable) for private firms in the UK over the period from 1993 to 2003. The difference in the results with those of Bougheas et al. (2009) shows that public listed firms in the UK are better positioned to access other sources of financing. This enables them to reduce reliance on trade credit as consistent with the proposition of having comparative advantages in accessing capital markets.

Comparisons of the effect of other short-term liabilities and cash on trade credit between innovative and non-innovative firms in the fifth and sixth columns show significant differences. Other short-term liabilities have a higher negative effect on trade credit for non-innovative firms than for innovative firms. The third and fourth columns that report separate estimations of Equation (6.1) show similar results. This indicates that firms with access to other short-term financing, such as non-innovative firms, substitute these for the relatively expensive trade credit. Consistent with this result, Ng et al. (1999) estimate that the implied interest rate on a "1/10 net 30" trade credit contract costs 18.25% in the US.[23] Similarly, a theoretical model by Biais and Gollier (1997) show that there is a significant substitution effect between trade credit and traditional forms of financing. The results in the fifth and sixth columns further show that most of the substitution is done by non-innovative firms, which have better access to other forms of financing.

Similar significant differences between innovative and non-innovative firms are also observed on the effects of cash on trade credit, with the exception that cash has an insignificant complementary effect on trade credit for non-innovative firms. This positive relationship between cash and trade credit for non-innovative firms suggests that non-innovative firms do not use the excess cash they generate to reduce trade credit. The results of estimating Equation (6.1) separately for non-innovative and innovative firms in the third and fourth columns show similar differences, with the coefficients being slightly higher than those reported in the fifth and sixth columns using the integrated model (Equation (6.2)). The positive effect of cash on trade credit (for innovative firms) is consistent with Love et al. (2007) on the emerging markets of Indonesia, Korea, Malaysia, the Philippines, and Thailand (1994 - 2001), Wu et al. (2012) on listed firms in China (2000-2007) and Garcia-Appendini and Montoriol-

[23] A "1/10 net 30" trade credit contract means that discount of 1% can be taken if the payment is made within 10 days and if the full credit period is used, the full payment is due in 30 days. The cost of credit is usually calculated as: Discount %/(1 - Discount %)*(360/(Full credit period days - Discount days).

Garriga (2013) on firms in the US (2005 - 2010). However, this positive effect is inconsistent with Bougheas et al. (2009) who investigate trade credit decisions of private firms in the UK. They argue that private firms in the UK use cash to reduce the relatively expensive trade credit financing. The difference in the results presented in Table 6.1 from those reported by Bougheas et al. (2009) suggests that listed non-innovative firms in the UK have less incentive to use cash to reduce trade credit (in contrast to private firms). This may be due to their ability to negotiate preferential credit terms given that they are listed and have better credit quality.

Coefficient estimates of the control variables are generally consistent with theoretical predictions and prior studies on the US, except for size (see, Abdulla et al., 2014b; Guariglia and Mateut, 2013; Kling et al., 2014; Petersen and Rajan, 1997). Tangible assets, intangible assets, size, profit and volatility have a negative and significant effect on accounts payable, while asset turnover has a positive effect. Firms with tangible assets are more able to access other forms of financing, hence use less trade credit. Trade credit appear to decrease with intangible assets, which also suggests that intangible assets play a similar role as tangible assets in facilitating access to other forms of debt financing.[24] The availability of other forms of financing to large and profitable firms reduces the need to use trade credit, which is considered to be relatively more expensive (see, inter alia, Ng et al., 1999; Wilner, 2000). The negative effect of earnings volatility (volatility) on trade credit shows that firms with high operating risks tend to use less trade credit as it tends to be difficult to get, especially when credit quality deteriorates or in tight credit markets. This result is consistent with Kahl et al. (2015) who report that firms in the US (over the period 1991-2008) with high roll-over risk rely more on bank credit and use less short-term debt (commercial paper). The differences of the effects of the control variables on trade credit between innovative and non-innovative firms are rather insignificant, except for asset turnover and profit which are higher for non-innovative firms than innovative

[24] Lim et al. (2014) report that both tangible and intangible assets are positively related to debt financing for firms in the US, contrary to the theoretical prediction that intangible assets are mostly financed with equity. Theories by Arrow (1962) and Nelson (1959) predict that intangible assets which are subject to high information asymmetry problems are a poor form of collateral and subject firms to binding credit constraints.

firms. This shows that the control variables have a roughly similar effect on trade credit policies of both innovative and non-innovative firms.

Overall, the results show significant differences on the effect of other short-term liabilities and cash on trade credit between innovative and non-innovative firms. The main contributions from the results is that other forms of short-term financing are used as substitutes to trade credit, with the substitution effect being significantly higher for non-innovative firms (which face less binding credit constraints) than innovative firms. The negative relationship between cash and trade credit shows that firms use the excess cash to reduce trade credit financing. This is due to trade credit being a less preferred form of short-term financing, as it is relatively more expensive and difficult to get when credit quality deteriorates and credit markets are tight. Similar differences are also observed in the relationship between cash and trade credit, with an insignificant complimentary effect for non-innovative firms and a significant substitution effect for innovative firms. This suggests that the reported negative relationship in the literature is mostly due to innovative firms that use the excess cash to reduce the relatively expensive and restrictive trade credit financing.

6.4.2 Accounts receivable, cash and short-term debt

Table 6.2 presents the estimating results of Equations (6.1) and (6.2) that relate accounts receivable (AR) to firm specific factors. The second, third and fourth columns present the estimating results of Equation (6.1) separately for all firms (ALL), non-innovative firms (NIN) and innovative firms (INN), respectively. The fifth and sixth columns present the estimating results of Equation (6.2) that allows for direct testing of the differences in the coefficients between non-innovative and innovative firms. All the estimated models include industry and time dummies.

The second column shows that other short-term liabilities have a significant positive effect on trade credit, while cash has a significant negative effect. This result indicates that firms that have access to short-term debt extend more trade credit, which

Table 6.2 Accounts receivable

The table presents the results of estimating Equations (6.1) and (6.2) that relate trade credit (AP or AR) to firm characteristics. ALL represent all firms (ALL) in the sample, non-innovative firms (NIN) are firms that do not report R&D, and innovative firms (INN) are firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1$^{\text{th}}$ and 99$^{\text{th}}$ percentiles. The data is drawn from Worldscope through Datastream. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	ALL	NIN	INN	NIN	INN	Diff (*p*-value)
Ostliab	0.053***	0.043	0.061***	0.028	0.059***	(0.377)
	(0.015)	(0.028)	(0.017)	(0.028)	(0.018)	
Cash	-0.177***	-0.077*	-0.253***	-0.080*	-0.248***	(0.001)
	(0.027)	(0.044)	(0.034)	(0.045)	(0.027)	
Tangible	-0.228***	-0.186***	-0.286***	-0.199***	-0.276***	(0.040)
	(0.024)	(0.031)	(0.031)	(0.032)	(0.026)	
Intangible	-0.192***	-0.180***	-0.228***	-0.159***	-0.239***	(0.016)
	(0.023)	(0.029)	(0.034)	(0.031)	(0.025)	
Size	-0.008***	-0.008***	-0.009***	-0.012***	-0.007***	(0.018)
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	
Profit	-0.018	-0.054*	0.015	-0.063**	0.008	(0.059)
	(0.017)	(0.030)	(0.018)	(0.030)	(0.021)	
AssetTurn	0.082***	0.097***	0.058***	0.091***	0.066***	(0.025)
	(0.009)	(0.009)	(0.013)	(0.008)	(0.012)	
Volatility	-0.019	-0.076	0.021	-0.114	0.035	(0.099)
	(0.037)	(0.080)	(0.036)	(0.079)	(0.042)	
Constant	0.284***	0.245***	0.382***	0.326***		
	(0.029)	(0.042)	(0.035)	(0.027)		
N	7579	2945	4634	7579		
$Adj.R^2$	0.616	0.637	0.632	0.623		

is consistent with the US studies of Cuñat (2007) and Petersen and Rajan (1997). They report that firms with better access to capital markets use this comparative advantage to benefit their customers by extending more trade credit. The negative effect of cash on accounts receivable (trade credit extended) is consistent with Dass et al. (2014) in emerging markets and Wu et al. (2012) for firms in China. Similarly, Bougheas et al. (2009) (private firms in the UK) and Petersen and Rajan (1997) (small firms in the US) also report a negative relationship between cash and trade credit extended. The negative effect of cash on trade credit shows that firms in the UK have to reduce trade credit (accounts receivable) in order to increase cash holdings.

The effect of other short-term liabilities on accounts receivable is positive, with no significant differences between innovative and non-innovative firms. The higher positive coefficient on other short-term liabilities suggests that innovative firms provide more trade credit (AR) to their customers. This is consistent with US studies that report higher trade credit extended in specialised industries than standardised industries (e.g., Guariglia and Mateut, 2013; Giannetti et al., 2011). The provision of relatively more trade credit by innovative firms is also consistent with the theoretical predictions that suppliers have informational advantages over traditional lenders, with these informational advantages being more pronounced for firms producing specialised products as highlighted by Guariglia and Mateut (2013) and Giannetti et al. (2011).[25] Also, Begenau and Palazzo (2015) report that some informed lenders in the US recognise the value of specialised collateral and advance credit at relatively lower rates than uninformed lenders who charge a premium to compensate for the information asymmetry in collateral values. Cash has a significantly higher negative effect on accounts receivable of innovative firms than for non-innovative firms. This difference suggests that cash is more valuable for innovative firms as it is used to smoothen shortfalls in cash-flows needed to finance further investments (see, Brown and Petersen, 2011). This high negative coefficient on cash for innovative firms supports the recently observed increase in cash-holdings among firms in the US, which has been attributed to an increase in operating risk and intangible investments (see, Acharya et al., 2007; Ang and Smedema, 2011).

Coefficient estimates of the control variables are mostly consistent with those in the literature, except for earnings volatility. The positive relation between trade credit and earnings volatility suggests that firms that have volatile profits may use trade credit to make up for the shortfall in cash-flows. Similarly, Borisova and Brown (2013) and Brown and Petersen (2011) report that firms in the US that invest in R&D use cash or proceeds from sales of fixed assets to smoothen shortfalls in cash-flows. A positive relation between trade credit and earnings volatility may occur if earnings volatility limits access to short-term debt, which may force firms to rely more on trade credit. Also, the high asset specificity for innovative firms may result in increased use of trade credit as the specialised nature of the collateral has more value to suppliers than other institutional lenders (such as banks) (see, Petersen and Rajan, 1997). Further, the differences in the effects of the control variables on trade

[25] See, Biais and Gollier (1997), Brennan and Schwartz (1984), Petersen and Rajan (1997) and Smith (1987).

credit (AR) between innovative and non-innovative firms are significant, which shows that these firms have heterogeneous trade credit policies as is also consistent with the results in Table 3.3 and Figure 3.4 (in Chapter 3).

The results show that it is mostly innovative firms in the UK that borrow to finance trade receivables, which is in line with prediction that firms with better access to capital markets extend more trade credit to their customers (see, Petersen and Rajan, 1997). Although non-innovative firms use other short-term financing sources to increase trade credit extended, this increase is insignificant. The results further indicate that innovative firms have to reduce trade credit extended significantly more than non-innovative firms in-order to save cash. The differences between non-innovative and innovative firms suggest that investment types are an important source of heterogeneity in trade credit and on how it relates to cash and short-term debt.

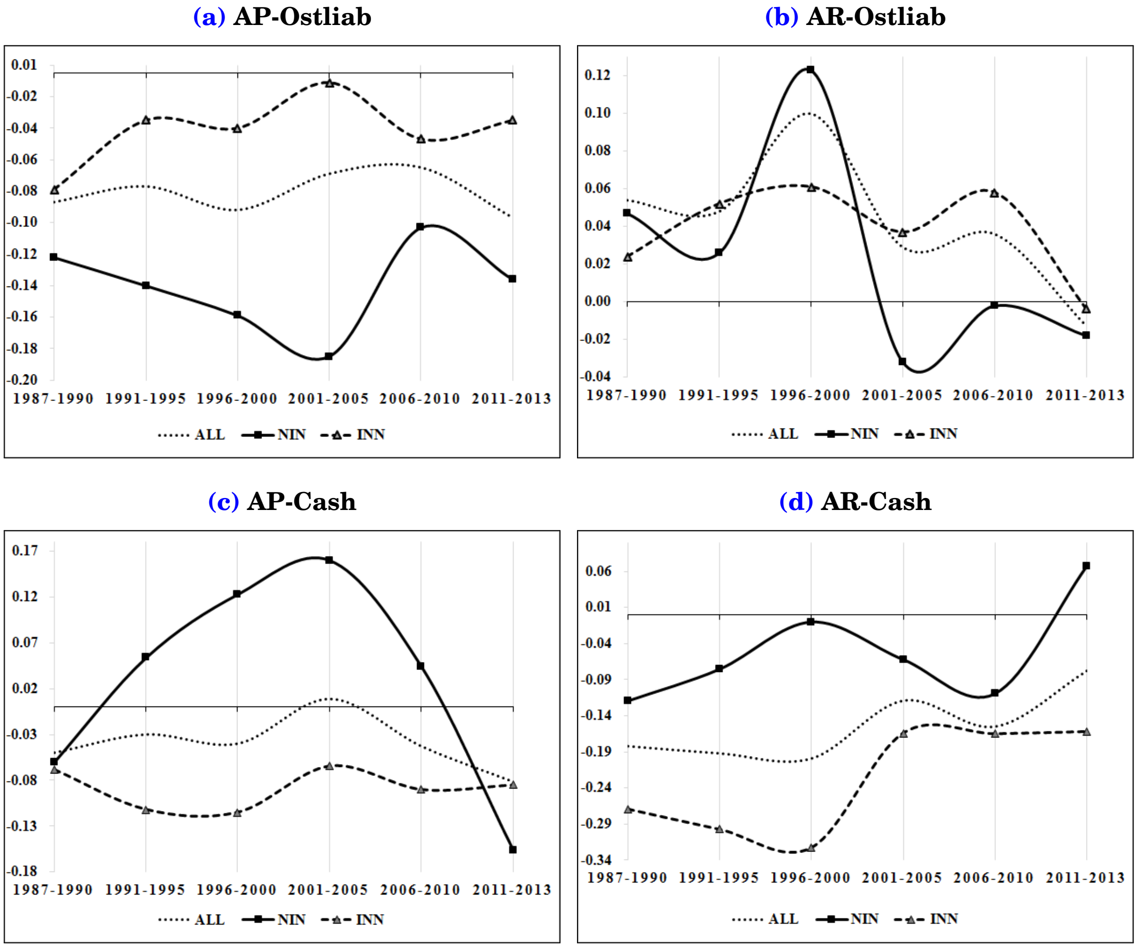
6.4.3 Time variations

This section builds upon the results in Table 6.1 by examining the time variation in the sensitivity of trade credit (AP and AR) to cash and other short-term liabilities (Ostliab). Figure 6.1 plots the time series of the sensitivities of trade credit from estimating Equation (6.1) for all firms and Equation (6.2) for innovative and non-innovative firms. The results are based on six non-overlapping sub-periods (1987-1990, 1991-1995, 1996-2000, 2001-2005, 2006-2010 and 2011-2013). The sensitivity of trade credit to cash and other short-term liabilities is estimated separately for all firms, non-innovative and innovative firms over the six sub-periods.

Figure 6.1 shows that the sensitivities of trade credit to cash and other short-term liabilities vary significantly over time.[26] For all firms (ALL), Figure 6.1a and 6.1c show that cash and other short-term liabilities appear as substitutes to trade credit (AP), except over the period 2001-2005 when cash assumes a complimentary role to

[26]Appendix 6.B shows the variation and differences in the sensitivity of trade credit to cash and other short-term liabilities.

Figure 6.1 **The sensitivity of trade credit over time**



trade credit. The negative relationship between trade credit (AP) and other short-term liabilities is in line with studies in the US (e.g., Love et al., 2007; Yang, 2011b), but inconsistent with Biais and Gollier (1997), Giannetti et al. (2011) and Demirguc-Kunt and Maksimovic (2001) who report that they are compliments. The result in Figure 6.1a suggests that the variation in the relationship between short-term debt and trade credit (AP) could explain the mixed results in the literature. The mostly negative relationship between trade credit (AP) and cash for all firms in Figure 6.1a is consistent with the proposition that firms with better liquidity positions tend to rely less on trade credit as it is a relatively expensive form of short-term financing.

Comparisons of the sensitivity of trade credit (AP) to cash and other short-term liabilities show marked differences between innovative and non-innovative firms. Figure 6.1c shows that cash has a positive effect on trade credit (AP) for non-innovative firms (for four out of the six periods), while it has a negative effect for innovative firms. This implies that cash assumes different roles for non-innovative and innovative firms, with innovative firms using cash to reduce trade credit (AP) while non-innovative firms use trade credit (AP) to increase cash. Although other short-term liabilities are mostly substitutes to trade credit (AP) in Figure 6.1a, this negative effect is significantly higher for non-innovative firms as is consistent with previous results in Table 6.1. This is empirical evidence of significant heterogeneity in the relationship between trade credit (AP) and cash or trade credit (AP) and other short-term financing sources conditional on investment types.

Figure 6.1b shows that other short-term liabilities have a positive effect on accounts receivable (AR), with this relationship changing to negative for non-innovative firms from 2001 to 2013. This suggests that it is mostly innovative firms that use their better access to other sources of financing to extend more trade credit to their customers. Although the results in Figure 6.1d are consistent in sign, comparisons show that cash has a significantly higher negative effect for innovative firms than non-innovative firms. The high negative effect of cash shows that innovative firms have to reduce trade credit significantly (more than non-innovative firms) in order to increase cash. This variation in the sensitivity of trade credit shows that the relationship between trade credit and cash, and trade credit and short-term debt changes over time and differs between innovative and non-innovative firms.[27]

Overall, the results in Figure 6.1 show that there are significant differences between innovative and non-innovative firms, as well as time variations in the sensitivity of trade credit to cash and other short-term liabilities.

6.4.4 Trade credit adjustments

This section investigates the differences in trade credit adjustments between innovative and non-innovative firms. The possible existence of a target trade credit level

[27] Appendix 6.C presents the estimating results of Equations (6.1) and (6.2) using 3 year sub-periods. These results are generally in line with those reported in Figure 6.1, except that they show more variation in the sensitivity of trade credit to cash and other short-term liabilities. Similar, significant differences between innovative and non-innovative firms is also observed in the sensitivity of net-trade credit to cash and other short-term liabilities in Appendix 6.E.

Table 6.3 Trade credit adjustments

The table presents the results of estimating Equations (6.3) and (6.4) that relate changes in trade credit (ΔAP or ΔAR) to deviation from target trade credit (Dev_{it}). ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. *RDD* a dummy variable that takes the value of one for firms that report R&D and zero otherwise. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream. Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Panel A: Accounts payable adjustments

	ALL	NIN	INN	ALL
Dev_{it}	0.201*** (0.014)	0.170*** (0.017)	0.238*** (0.021)	0.162*** (0.017)
$Dev_{it} \times RDD$				0.075*** (0.028)
N	7579	2945	4634	7579
$Adj.R^2$	0.141	0.100	0.184	0.144

Panel B: Accounts receivable adjustments

	ALL	NIN	INN	ALL
Dev_{it}	0.174*** (0.023)	0.132*** (0.015)	0.233*** (0.044)	0.129*** (0.015)
$Dev_{it} \times RDD$				0.094* (0.049)
N	7579	2945	4634	7579
$Adj.R^2$	0.06	0.051	0.075	0.064

is premised on the proposition that firms seek to optimise the trade-off between the costs and benefits of giving or using trade credit so as to maximise firm value. The second, third and fourth columns of Table 6.3 present estimation results of Equation (6.3) separately for all firms, non-innovative and innovative firms, respectively. The fifth column presents estimation results of Equation (6.3) which include the interaction term, $Dev_{it} \times RDD$, in order to examine the differences in the adjustment behaviour of firms that report R&D. All models in Table 6.3 include firm fixed effects and time dummies.

The results in the second column of Table 6.3 (Panel A) show that all firms adjust towards the target trade credit at a slow-to-moderate rate of 20.1% for accounts payable (AP). This suggests that there are significant adjustment costs that result in firms "taking extended excursions away from their targets" as highlighted by Myers (1984) on capital structure. The significant speed of adjustment also suggests that firms have a target trade credit level, with non-innovative firms adjusting at a lower speed than innovative firms. The results in the fifth column are consistent with the initial proposition that innovative firms benefit relatively more from adjusting towards the target. These results show that innovative firms adjust at a speed of 23.7%, which is 7.5% faster than non-innovative firms (16.2%). The results of estimating Equations (6.3) separately for non-innovative firms in the third column (17%) and innovative firms in the fourth column (23.8%) show similar significant differences in the speed of adjustment as that reported in the fifth column. This relatively higher speed of adjustment indicates that trade credit is less persistent from one year to the next for innovative firms, as it is a relatively expensive form of short-term financing. This low persistence for innovative firms is consistent with the proposition that these firms tend to avoid short-term debt (such as trade credit) that restricts flexibility (see, O'Brien, 2003) and is often difficult to get (especially when credit quality deteriorates) (see, Kahl et al., 2015). Overall, the main contribution to the literature from the results in Panel A is that the benefits arising from adjusting trade credit towards the target are asymmetric conditional on investment types, with innovative firms benefiting more than non-innovative firms. This difference in the speed of adjustment indicates that the overlooked investment types are an important source of heterogeneity in trade credit adjustments.

The results in Panel B for accounts receivable (AR) also show similar slow-to-moderate speeds of adjustment (as those reported in Panel A for accounts payable). The speed of adjustment of AR for all firms (in the second column) is 17.4%, while non-innovative (innovative) firms adjust at a slow-to-moderate speed of 0.132 (23.3%). Similarly, the results in the fifth column show that innovative firms (22.3%) are more active in rebalancing trade credit towards the target than non-innovative firms (12.9%). The relatively higher speed of adjustment for innovative firms (which is 9.4% faster than for non-innovative firms) is consistent with the initial predictions in this chapter and the results in Table 3.3 and Figure 3.4 of Chapter 3, which show that innovative firms extend more trade credit (accounts receivable) than non-innovative firms.[28] This re-

[28]Appendix 6.D presents results on net trade credit adjustment. The results show that all firms adjust net trade credit at a slow-to-moderate speed (25.1%) and that innovative firms consistently adjust faster than non-innovative firms towards a target. This slow-to-moderate speed is consistent

sult supports the proposition that trade credit is used to alleviate imperfections in the product markets as it allows customers to try the product before making a payment (see, Antràs and Foley, 2011; Lee and Stowe, 1993; Long et al., 1993). The relatively higher speed of adjustment for innovative firms further implies that the option to take trade credit is more valuable for innovative products, as it allows suppliers to use trade credit extended as a form of warranty on product quality.[29,30]

Overall, the results in Table 6.3 show that investment types are an important source of heterogeneity in trade credit adjustments. Understanding how investments in innovation impact on other corporate financing decisions (such as trade credit) is becoming more important with the increasing dominance of the technology and service sectors. Further, these results add new insights on the overlook interdependence of financing and investment decisions.[31]

6.5 Robustness

This section presents robustness tests. First, using net trade credit as the dependent variable, this section re-estimates Equations (6.3) and (6.4) (in Table 6.4) that relate net trade credit (NTC) to firm characteristics. Net trade credit is defined as the difference between accounts receivable and accounts payable.[32] The focus on net trade credit is motivated by Guariglia and Mateut (2006) who argue that it is a more comprehensive measure as firms do not only limit themselves to receiving trade credit (accounts payable), but also extend trade credit (accounts receivable). The policies on

with the results in Table 6.3. The fifth and sixth columns show that innovative firms adjust net trade credit at a higher speed of 16.8% while non-innovative firms adjust at a speed of 33.3%. Similar differences are also observed in the third and fourth columns that present the estimating results of Equation (6.3) separately for non-innovative and innovative firms.

[29] According to Long et al. (1993), firms use trade credit extended as a form of guarantee for product quality. This helps in alleviating information asymmetry in the product markets in a similar way that trade credit reduces information asymmetry in the capital markets (supplier based lending (see, Biais and Gollier, 1997)).

[30] O'Brien (2003) highlights that firms in competitive markets for innovation need to constantly change their strategies in order to survive (strategic flexibility).

[31] See, inter alia, Buera and Kaboski (2012), Chava and Roberts (2008) and Stein (2003).

[32] Other studies have used accounts payable and receivable scaled by sales and cost of goods sold as the measure for trade credit (e.g., Abdulla et al., 2014a; Aktas et al., 2012; Garcia-Appendini and Montoriol-Garriga, 2013; Giannetti et al., 2011; Love et al., 2007). However, this study uses net trade credit for robustness tests as it is more informative (Guariglia and Mateut, 2006).

Table 6.4 Net trade credit

The table presents the results of estimating Equations (6.3) and (6.4) that relate net trade credit (NTC) to firm characteristics. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1$^{\text{th}}$ and 99$^{\text{th}}$ percentiles. The data is drawn from Worldscope through Datastream. Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. All models include firm fixed effects and time dummies (in the rela).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	ALL	NIN	INN	NIN	INN	Diff (*p*-value)
Ostliab	0.124***	0.177***	0.087***	0.169***	0.086***	(0.019)
	(0.017)	(0.029)	(0.019)	(0.030)	(0.019)	
Cash	-0.132***	-0.140***	-0.147***	-0.127***	-0.148***	(0.639)
	(0.023)	(0.040)	(0.029)	(0.040)	(0.025)	
Tangible	-0.172***	-0.155***	-0.196***	-0.149***	-0.202***	(0.082)
	(0.022)	(0.032)	(0.026)	(0.028)	(0.022)	
Intangible	-0.133***	-0.134***	-0.142***	-0.109***	-0.159***	(0.099)
	(0.021)	(0.030)	(0.027)	(0.028)	(0.021)	
Size	-0.006***	-0.007***	-0.006***	-0.009***	-0.005***	(0.038)
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	
Profit	0.084***	0.079**	0.097***	0.073**	0.088***	(0.705)
	(0.018)	(0.037)	(0.020)	(0.035)	(0.020)	
AssetTurn	-0.015**	-0.015**	-0.016*	-0.019***	-0.011	(0.363)
	(0.006)	(0.008)	(0.009)	(0.007)	(0.008)	
Volatility	0.021	-0.027	0.044	-0.046	0.048	(0.355)
	(0.045)	(0.084)	(0.050)	(0.086)	(0.054)	
Constant	0.191***	0.183***	0.316***	0.289***		
	(0.027)	(0.043)	(0.032)	(0.025)		
N	7579	2945	4634	7579		
$Adj.R^2$	0.341	0.357	0.327	0.348		

accounts receivables and accounts payable differ as firms have an inventive to delay making payments to their suppliers and require early or prompt receipts from their customers.[33] However, in this analysis, the definition of net trade credit of Guariglia and Mateut (2006), which involves subtracting accounts payable from accounts receivable, is used for robustness. The second, third and fourth columns in Table 6.4 present the estimating results of Equation (6.1) separately for all firms (ALL), non-innovative firms (NIN) and innovative firms (INN), respectively. The fifth and sixth columns present the estimating results of Equation (6.2) that allows for direct testing of the differences in the coefficients between non-innovative and innovative firms. The values in parentheses are the associated standard errors. All models include firm fixed effects and time dummies to control for other excluded firm-specific and time factors that might affect trade credit.

[33]Similarly, Barclay and Smith (1995) argue that there is no economic rationale to expect the same results from different definitions of a variable (such as when leverage when it is measured based on market or book value). The same arguments can be made when using net trade credit to measure trade credit (accounts receivable or accounts payable).

Table 6.5 Trade credit, cash & other short-term liabilities: Other estimation techniques

The table presents the results of estimating Equation (6.2) that relates trade credit (AP or AR) to firm characteristics. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in DPF3.2 in Chapter 3, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. The results are estimated by OLS with Newey-West standard errors (NEWEY), Fama and MacBeth (1973) (FM) and the DPF (Elsas and Florysiak, 2011, 2013). According to Elsas and Florysiak (2011), the DPF estimator is a doubly-censored tobit estimator ([0,1]), which relies on a latent variable approach to explicitly account for the fractional nature of ratios. Standard errors are reported in parenthesis. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Panel A: Accounts payable (AP)

	NIN	INN	Diff (*p*-value)	NIN	INN	Diff (*p*-value)	NIN	INN	Diff (*p*-value)
Ostliab	-0.141***	-0.028**	(0.000)	-0.139***	-0.032***	(0.000)	-0.080***	-0.037***	(0.000)
	(0.016)	(0.011)		(0.016)	(0.007)		(0.008)	(0.006)	
Cash	0.047	-0.100***	(0.000)	0.029	-0.101***	(0.002)	-0.002	-0.077***	(0.000)
	(0.029)	(0.014)		(0.036)	(0.010)		(0.011)	(0.008)	
Industry	YES			NO			YES		
Year	YES			NO			YES		
Controls	YES			YES			YES		
Method	NEWEY			FM			DPF		
N	7579			7579			7579		

Panel B: Accounts receivable (AR)

	NIN	INN	Diff (*p*-value)	NIN	INN	Diff (*p*-value)	NIN	INN	Diff (*p*-value)
Ostliab	0.028	0.059***	(0.230)	0.082***	0.066***	(0.539)	0.017	0.055***	(0.006)
	(0.021)	(0.014)		(0.023)	(0.010)		(0.012)	(0.008)	
Cash	-0.080**	-0.248***	(0.000)	0.048**	-0.194***	(0.000)	-0.176***	-0.211***	(0.062)
	(0.034)	(0.019)		(0.020)	(0.039)		(0.015)	(0.011)	
Industry	YES			NO			YES		
Year	YES			NO			YES		
Controls	YES			YES			YES		
Method	NEWEY			FM			DPF		
N	7579			7579			7579		

The results in Table 6.4 show that other short-term liabilities have a positive effect on net trade credit, while cash has a negative effect. Comparisons of the effect of other short-term liabilities on net-trade credit (fifth and sixth columns) show significant differences between innovative and non-innovative firms, with the positive effect being higher for non-innovative firms. This indicates that short term debt is used to finance trade receivables, with non-innovative firms channelling more of the short-term borrowings towards extending more trade credit to their customers. This is inconsistent with the results reported in Table 6.2 and Figure 3.4e. Rather, Figure 3.4e shows that innovative firms have more other short-term liabilities, which could be used to increase the trade credit they extend to their customers. While the results in Table 6.4 show that cash has a significantly higher positive effect on net trade credit for non-innovative firms, Table 6.2 shows that the difference is rather insignificant even though this positive effect is higher for innovative firms. This difference in the results is caused by the inclusion of accounts payable (AP) in net-trade credit.

Cash has a consistently negative effect on net trade credit. This shows that firms have to reduce the trade credit they extend to their customers in order to increase cash holdings. In contrast to the results in Tables 6.1 and 6.2, the difference on the effect of cash on net trade credit between innovative and non-innovative firms is insignificant although it is slightly higher for innovative firms. The negative effect of cash on trade credit is consistent with Dass et al. (2014) and Wu et al. (2012) who report similar results for firms in emerging markets and firms in China, respectively. The results on other determinants are generally in line with those reported previously in this chapter (Section 6.1 and 6.2).

Finally, this section examines the sensitivity of the results to other estimation techniques (OLS with Newey-West standard errors (NEWEY), Fama and MacBeth (FM) (see, Fama and MacBeth, 1973) and DPF (see, Elsas and Florysiak, 2011, 2013)). The focus on the three techniques is motivated by the on ongoing debate in the literature on the most appropriate estimation techniques in corporate finance (see, inter alia, Dang et al., 2014b; Elsas and Florysiak, 2008; Flannery and Hankins, 2013). Table 6.5 shows limited differences across the three different estimation techniques.[34] Panel A shows that other short-term liabilities have a consistent negative effect on accounts payable as is consistent with the results in Table 6.1. This indicates that other-short-term liabilities are a substitute to trade credit (accounts payable). The results also show this negative effect differs significantly between innovative and non-innovative firms as reported in Table 6.1. Cash has a consistently negative effect on accounts payable for innovative firms, while it has an insignificant positive effect for non-innovative firms, except for the negative coefficient estimated using the DPF. The positive effect of cash on trade credit (AP) for non-innovative firms and the negative effect for innovative firms is in line with the results in Table 6.1. These results corroborate those reported in Table 6.1 and also suggest that innovative (non-innovative) firms use (do not use) cash to reduce trade credit financing.

Panel B shows a positive relationship between other short-term liabilities and trade credit extended (accounts receivable). This positive relationship suggests that firms use short-term financing to increase the trade credit extended (AR) as is consistent with the results in Table 6.2. The result is also in line with the proposition that firms with access to capital markets provide more credit to their customers and also support other credit constrained firms.[35] However, comparisons between innovative and non-innovative firms show that the differences on the effect of other short-term liabilities on trade credit extended (AR) are rather insignificant, except for the model estimated using the DPF approach.[36] The results in Panel B further show that cash has a consistently negative effect on accounts receivable, except for the models estimated using the Fama and MacBeth approach. This result is similar to that reported in Table 6.2, except for the insignificant differences and positive effect of cash on trade credit (accounts receivable) of non-innovative firms for the models estimated

[34]Table 6.5 only presents results on other short-term liabilities and cash. The coefficients of the control variables (short-term debt, cash, tangible assets, intangible assets, sales growth, size, profit, asset turnover and volatility) remain qualitatively similar to those presented in previous sections of the chapter (Table 6.1 and 6.2).

[35]Petersen and Rajan (1997) report that firms in the US with better access to capital markets extend more trade credit to their customers.

[36]The DPF approach that accounts for the censored nature of variables (such as ratios that within the unit interval [0,1]).

using the Fama and MacBeth approach. The results are generally in line with those reported in Tables 6.1 and 6.2.

Overall, the main results seem robust to different definitions of trade credit and are qualitatively similar across several estimation techniques. This shows that recognising heterogeneity conditional on investments types is important to the understanding of variations in trade credit policies, the relationship between trade credit and cash, and the relationship between trade credit and other forms of short-term financing.

6.6 Conclusion

This chapter investigates the determinants of trade credit, and the differences in trade credit between innovative and non-innovative firms. Further, the chapter also examines the time variations in the relationship between trade credit and cash-holdings, and between trade credit and short-term debt. Several insights on trade credit policies emerge. First, the results show that relationship between trade credit and cash-holdings, and between trade credit and short-term debt varies over time and across innovative and non-innovative firms. There is a high substitution effect between short-term debt and accounts payable, while there is a complimentary effect between short-term debt and accounts receivable. Further, the substitution effect between short-term debt and accounts payable is higher for non-innovative firms than for innovative firms, which suggests that non-innovative firms use less trade credit financing for every unit of short-term debt they are able to access.

Second, the effect of cash on trade credit is asymmetric as it has a negative effect on both accounts payable and accounts receivable for innovative firms, while it has a positive effect on accounts payable and a negative effect on accounts receivable for non-innovative firms. This evidence suggests that cash and trade credit (AP) have a complimentary relationship for non-innovative firms, whereas the two are substitutes for innovative firms. Innovative firms tend to substitute trade credit with short-term debt as trade credit is a relatively more expensive form of short-term financing and relying on it reduces flexibility as it is often difficult to get in tight credit markets or if credit quality deteriorates. Further, innovative investments have long investment horizons which favour long-term financing sources as firms seek to match the maturity of assets to the sources of financing.

Third, the sensitivity of trade credit to cash and other short-term liabilities varies over time and between innovative and non-innovative firms. Whereas cash is a compliment to trade credit (AP) for non-innovative firms, it is a substitute to trade credit (AP) for innovative firms. There are similar differences on other short-term liabilities which consistently have a substitution effect on trade credit (AP), with the substitution effect being significantly higher for non-innovative firms that face less binding financial constraints. Comparisons on the the sensitivity of accounts receivable (trade credit extended) between innovative and non-innovative firms show significant differences as other short-term liabilities are a compliment to trade credit extended (AR), but change to being a substitute during the periods 2001-2005, 2006-2010 and 2011-2013 for non-innovative firms. Similar differences are also observed from comparisons of the sensitivity of trade credit extended (AR) to cash. While the relationship between trade credit extended is mostly negative, it is rather less significant and changes to positive for non-innovative firms over the period 2011-2013. These results show the importance of studying the dynamic nature of the relationship between trade credit and other short-term sources of financing (short-term debt and cash), and the heterogeneity in trade credit arising from differences in corporate investments.

Finally, the results show that listed firms in the UK adjust towards a target credit level at a slow-to-moderate speed. This slow-to-moderate speed of adjustment is due to the existence of adjustment costs that impede firms from fully adjusting towards the target trade credit level. Comparisons of the speed of adjustment between non-innovative and innovative firms show that innovative firms consistently adjust faster than non-innovative firms. This highlights the importance of recognising heterogeneity in trade credit conditional on investment types since innovative firms benefit more from re-balancing trade credit towards the target than non-innovative firms.

Appendices to Chapter 6

Appendix 6.A Variations in trade credit

The table reports the number of observations (N), mean, median, standard deviation (Stdev), 25th and 75th percentiles for the variables used. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. AP-Diff (AR-Diff) represents differences in account payables (account receivables) between innovative firms and non-innovative firms. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream.

	NIN			INN			AP-Diff	AR-Diff
Year	N	AP	AR	N	AP	AR	(p-value)	(p-value)
1987	50	0.087	0.214	111	0.051	0.253	(0.009)	(0.019)
1988	113	0.141	0.250	155	0.097	0.274	(0.001)	(0.085)
1989	143	0.169	0.250	172	0.148	0.267	(0.032)	(0.178)
1990	177	0.152	0.233	234	0.147	0.258	(0.471)	(0.023)
1991	193	0.152	0.234	246	0.137	0.254	(0.047)	(0.041)
1992	197	0.149	0.227	252	0.139	0.254	(0.168)	(0.006)
1993	201	0.153	0.230	262	0.141	0.257	(0.124)	(0.007)
1994	201	0.167	0.249	270	0.146	0.261	(0.011)	(0.248)
1995	188	0.173	0.258	259	0.153	0.263	(0.019)	(0.601)
1996	180	0.175	0.253	251	0.150	0.270	(0.004)	(0.134)
1997	171	0.169	0.253	248	0.142	0.267	(0.002)	(0.231)
1998	153	0.166	0.248	229	0.138	0.247	(0.002)	(0.914)
1999	122	0.155	0.237	201	0.128	0.239	(0.003)	(0.846)
2000	106	0.158	0.216	175	0.124	0.235	(0.004)	(0.218)
2001	100	0.150	0.210	177	0.115	0.215	(0.002)	(0.691)
2002	93	0.142	0.207	182	0.111	0.208	(0.005)	(0.966)
2003	95	0.144	0.205	170	0.118	0.212	(0.023)	(0.610)
2004	93	0.138	0.199	171	0.110	0.211	(0.014)	(0.472)
2005	91	0.141	0.198	164	0.111	0.200	(0.011)	(0.899)
2006	85	0.126	0.173	159	0.110	0.197	(0.157)	(0.089)
2007	87	0.102	0.178	155	0.108	0.202	(0.601)	(0.157)
2008	89	0.112	0.167	160	0.102	0.186	(0.374)	(0.170)
2009	92	0.098	0.145	159	0.097	0.178	(0.887)	(0.018)
2010	86	0.099	0.144	151	0.103	0.187	(0.755)	(0.008)
2011	79	0.105	0.164	135	0.108	0.178	(0.846)	(0.423)
2012	68	0.108	0.161	127	0.107	0.172	(0.960)	(0.518)
2013	51	0.103	0.150	117	0.105	0.180	(0.893)	(0.143)
Total	**3304**	**0.147**	**0.220**	**5092**	**0.125**	**0.233**	**(0.000)**	**(0.000)**

Appendix 6.B Trade credit, cash & other short-term liabilities: Time variations

The table presents the results of estimating Equations (6.1) and (6.2) that relate trade credit (AP or AR) to firm characteristics. ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Panel A: Accounts payable: All firms

Period	Firms	OSTLIB	Cash	Tangible	Intangible	Size	Profit	AssetTurn	Volatility	Constant	N	$Adj.R^2$
1987-1990	ALL	-0.082*** (0.029)	-0.050* (0.029)	-0.071*** (0.022)	-0.048 (0.070)	-0.007*** (0.002)	-0.166*** (0.059)	0.077*** (0.009)	-0.040 (0.116)	0.106*** (0.032)	744	0.490
1991-1995	ALL	-0.072*** (0.018)	-0.030 (0.025)	-0.052*** (0.020)	-0.054* (0.031)	-0.002* (0.001)	-0.144*** (0.024)	0.102*** (0.008)	-0.012 (0.060)	0.068*** (0.022)	2156	0.600
1996-2000	ALL	-0.087*** (0.018)	-0.040 (0.028)	-0.055** (0.025)	-0.062* (0.033)	-0.001 (0.001)	-0.084*** (0.023)	0.093*** (0.010)	0.104* (0.059)	0.070** (0.029)	1742	0.528
2001-2005	ALL	-0.064** (0.032)	0.009 (0.060)	-0.032 (0.040)	-0.028 (0.040)	-0.003* (0.002)	-0.075** (0.031)	0.109*** (0.016)	-0.021 (0.045)	0.085** (0.039)	1236	0.584
2006-2010	ALL	-0.060** (0.024)	-0.043 (0.046)	-0.070** (0.034)	-0.071** (0.033)	-0.001 (0.002)	-0.101*** (0.023)	0.091*** (0.012)	-0.233*** (0.052)	0.109** (0.045)	1124	0.586
2011-2013	ALL	-0.092*** (0.035)	-0.082 (0.056)	-0.067* (0.036)	-0.084** (0.040)	0.000 (0.002)	-0.166*** (0.037)	0.108*** (0.013)	-0.186** (0.077)	0.088* (0.045)	577	0.666

Panel B: Accounts receivable: All firms

Period	Firms	OSTLIB	Cash	Tangible	Intangible	Size	Profit	AssetTurn	Volatility	Constant	N	$Adj.R^2$
1987-1990	ALL	0.054 (0.038)	-0.182*** (0.047)	-0.199*** (0.038)	-0.072 (0.076)	-0.012*** (0.003)	-0.036 (0.070)	0.073*** (0.012)	-0.184 (0.255)	0.332*** (0.046)	744	0.555
1991-1995	ALL	0.048** (0.022)	-0.192*** (0.036)	-0.247*** (0.029)	-0.221*** (0.039)	-0.006*** (0.002)	0.003 (0.034)	0.074*** (0.010)	0.113 (0.116)	0.257*** (0.035)	2156	0.604
1996-2000	ALL	0.100*** (0.025)	-0.199*** (0.040)	-0.210*** (0.036)	-0.168*** (0.042)	-0.009*** (0.002)	-0.015 (0.027)	0.078*** (0.012)	0.022 (0.062)	0.273*** (0.041)	1742	0.610
2001-2005	ALL	0.029 (0.032)	-0.119** (0.058)	-0.179*** (0.047)	-0.140*** (0.039)	-0.008*** (0.002)	-0.057 (0.036)	0.118*** (0.017)	-0.071* (0.040)	0.244*** (0.049)	1236	0.599
2006-2010	ALL	0.036 (0.028)	-0.155*** (0.050)	-0.249*** (0.043)	-0.200*** (0.042)	-0.005*** (0.002)	-0.011 (0.027)	0.078*** (0.013)	-0.026 (0.122)	0.285*** (0.040)	1124	0.603
2011-2013	ALL	-0.013 (0.050)	-0.078 (0.075)	-0.260*** (0.039)	-0.225*** (0.036)	-0.007*** (0.002)	0.011 (0.030)	0.075*** (0.010)	-0.082 (0.077)	0.306*** (0.043)	577	0.665

Appendix 6.B Trade credit, cash & other short-term liabilities: Time variations (continued)

Panel C: Accounts payable: Innovative and Non-innovative firms

Period	Firms	OSTLIB	Cash	Tangible	Intangible	Size	Profit	AssetTurn	Volatility	Constant	N	$Adj.R^2$
1987-1990	NIN	-0.117**	-0.060	-0.052*	-0.012	-0.007**	-0.196*	0.086***	-0.290*	0.110***	744	0.492
		(0.052)	(0.044)	(0.031)	(0.184)	(0.003)	(0.104)	(0.011)	(0.167)			
	INN	-0.074**	-0.068*	-0.094***	-0.082	-0.006***	-0.127**	0.068***	0.191	(0.035)		
		(0.032)	(0.036)	(0.028)	(0.063)	(0.002)	(0.062)	(0.013)	(0.150)			
	p-value	(0.498)	(0.891)	(0.298)	(0.707)	(0.745)	(0.559)	(0.242)	(0.025)			
1991-1995	NIN	-0.135***	0.054	-0.043*	-0.042	-0.004*	-0.189***	0.112***	-0.046	0.082***	2156	0.612
		(0.036)	(0.044)	(0.024)	(0.045)	(0.002)	(0.040)	(0.009)	(0.084)			
	INN	-0.030*	-0.112***	-0.086***	-0.086**	-0.002	-0.094***	0.084***	0.043	(0.066)		
		(0.017)	(0.026)	(0.027)	(0.040)	(0.001)	(0.029)	(0.010)	(0.066)			
	p-value	(0.009)	(0.001)	(0.185)	(0.451)	(0.332)	(0.059)	(0.021)	(0.408)			
1996-2000	NIN	-0.154***	0.123**	-0.056	-0.057	-0.002	-0.111**	0.097***	0.122	0.082***	1742	0.545
		(0.032)	(0.059)	(0.034)	(0.046)	(0.003)	(0.045)	(0.013)	(0.106)			
	INN	-0.035*	-0.115***	-0.078***	-0.110***	-0.001	-0.071***	0.077***	0.089*	(0.030)		
		(0.021)	(0.025)	(0.026)	(0.031)	(0.002)	(0.023)	(0.012)	(0.051)			
	p-value	(0.003)	(0.000)	(0.573)	(0.319)	(0.789)	(0.442)	(0.154)	(0.782)			
2001-2005	NIN	-0.180***	0.160	-0.018	-0.023	-0.005*	-0.092**	0.125***	-0.041	0.099***	1236	0.617
		(0.047)	(0.114)	(0.043)	(0.050)	(0.003)	(0.046)	(0.015)	(0.107)			
	INN	-0.006	-0.064*	-0.059*	-0.056*	-0.003	-0.062*	0.079***	-0.006	(0.032)		
		(0.039)	(0.038)	(0.030)	(0.030)	(0.002)	(0.034)	(0.015)	(0.042)			
	p-value	(0.005)	(0.048)	(0.328)	(0.496)	(0.490)	(0.593)	(0.010)	(0.765)			
2006-2010	NIN	-0.098***	0.044	-0.066*	-0.067*	-0.003	-0.147***	0.105***	-0.326***	0.119**	1124	0.601
		(0.037)	(0.072)	(0.035)	(0.037)	(0.002)	(0.042)	(0.012)	(0.089)			
	INN	-0.042	-0.090*	-0.073**	-0.085**	-0.001	-0.074***	0.069***	-0.157**	(0.046)		
		(0.028)	(0.048)	(0.036)	(0.034)	(0.002)	(0.027)	(0.014)	(0.064)			
	p-value	(0.213)	(0.053)	(0.824)	(0.577)	(0.415)	(0.123)	(0.007)	(0.103)			
2011-2013	NIN	-0.131***	-0.156*	-0.093**	-0.136***	-0.002	-0.112***	0.123***	-0.071	0.134***	577	0.686
		(0.049)	(0.085)	(0.041)	(0.049)	(0.002)	(0.041)	(0.010)	(0.075)			
	INN	-0.030	-0.085	-0.076*	-0.082**	-0.001	-0.176***	0.082***	-0.275**	(0.047)		
		(0.041)	(0.053)	(0.041)	(0.040)	(0.002)	(0.044)	(0.017)	(0.120)			
	p-value	(0.114)	(0.369)	(0.677)	(0.245)	(0.754)	(0.268)	(0.015)	(0.136)			

Appendix 6.B Trade credit, cash & other short-term liabilities: Time variations (continued)

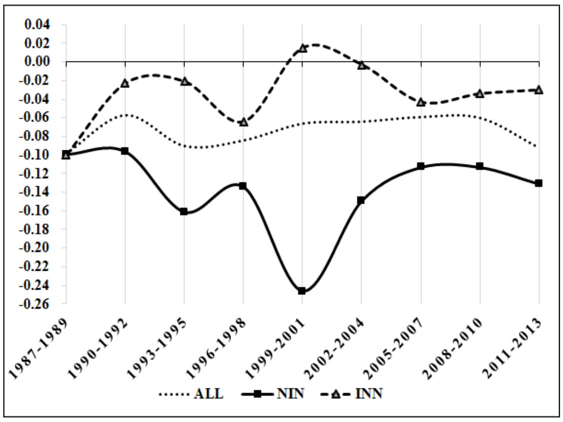
Panel D: Accounts receivable: Innovative and Non-innovative firms

Period	Firms	OSTLIB	Cash	Tangible	Intangible	Size	Profit	AssetTurn	Volatility	Constant	N	$Adj.R^2$
1987-1990	NIN	0.047	-0.119	-0.150***	0.202	-0.018***	-0.057	0.086***	-0.808***	0.356***	744	0.584
		(0.057)	(0.074)	(0.047)	(0.149)	(0.004)	(0.111)	(0.012)	(0.203)			
	INN	0.024	-0.269***	-0.286***	-0.271***	-0.009***	0.006	0.052***	0.351	(0.048)		
		(0.048)	(0.059)	(0.043)	(0.058)	(0.003)	(0.073)	(0.015)	(0.330)			
	p-value	(0.757)	(0.124)	(0.018)	(0.003)	(0.022)	(0.623)	(0.051)	(0.002)			
1991-1995	NIN	0.026	-0.075	-0.231***	-0.198***	-0.012***	-0.040	0.083***	0.056	0.295***	2156	0.614
		(0.046)	(0.053)	(0.038)	(0.054)	(0.003)	(0.055)	(0.010)	(0.168)			
	INN	0.052**	-0.297***	-0.298***	-0.280***	-0.006***	0.046	0.054***	0.204*	(0.106)		
		(0.025)	(0.035)	(0.030)	(0.045)	(0.002)	(0.048)	(0.015)	(0.106)			
	p-value	(0.629)	(0.000)	(0.114)	(0.221)	(0.037)	(0.271)	(0.067)	(0.460)			
1996-2000	NIN	0.123***	-0.010	-0.152***	-0.184***	-0.018***	-0.053	0.081***	-0.068	0.325***	1742	0.624
		(0.046)	(0.065)	(0.045)	(0.053)	(0.003)	(0.042)	(0.012)	(0.084)			
	INN	0.061**	-0.322***	-0.321***	-0.200***	-0.007***	0.009	0.062***	0.075	(0.041)		
		(0.028)	(0.039)	(0.033)	(0.049)	(0.002)	(0.038)	(0.016)	(0.085)			
	p-value	(0.249)	0.000	(0.001)	(0.814)	(0.000)	(0.291)	(0.221)	(0.236)			
2001-2005	NIN	-0.032	-0.062	-0.131**	-0.102*	-0.011***	-0.169***	0.127***	-0.183	0.266***	1236	0.607
		(0.050)	(0.116)	(0.060)	(0.061)	(0.004)	(0.060)	(0.014)	(0.113)			
	INN	0.037	-0.164***	-0.231***	-0.188***	-0.007**	-0.021	0.104***	-0.042	(0.047)		
		(0.045)	(0.056)	(0.056)	(0.043)	(0.003)	(0.030)	(0.024)	(0.038)			
	p-value	(0.327)	(0.402)	(0.204)	(0.227)	(0.379)	(0.026)	(0.286)	(0.248)			
2006-2010	NIN	-0.002	-0.109	-0.242***	-0.174***	-0.004	-0.040	0.081***	-0.345***	0.288***	1124	0.611
		(0.040)	(0.087)	(0.050)	(0.052)	(0.003)	(0.043)	(0.015)	(0.118)			
	INN	0.058*	-0.165***	-0.251***	-0.209***	-0.006***	0.000	0.071***	0.155	(0.039)		
		(0.034)	(0.046)	(0.046)	(0.040)	(0.002)	(0.031)	(0.013)	(0.112)			
	p-value	(0.225)	(0.494)	(0.839)	(0.407)	(0.622)	(0.447)	(0.485)	(0.003)			
2011-2013	NIN	-0.018	0.067	-0.251***	-0.219***	-0.011***	0.003	0.088***	-0.128	0.330***	577	0.673
		(0.066)	(0.169)	(0.044)	(0.047)	(0.004)	(0.045)	(0.012)	(0.087)			
	INN	-0.004	-0.162**	-0.278***	-0.246***	-0.007***	0.048	0.051***	0.085	(0.041)		
		(0.057)	(0.075)	(0.046)	(0.039)	(0.002)	(0.036)	(0.014)	(0.162)			
	p-value	(0.870)	(0.196)	(0.567)	(0.585)	(0.335)	(0.410)	(0.013)	(0.246)			

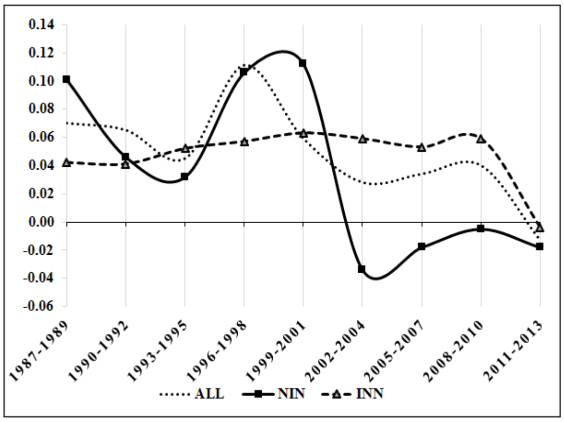
Appendix 6.C The sensitivity of trade credit: 3 year sub-periods

The figure plots the time series of the sensitivities of net trade credit from estimating Equations (6.1) and (6.2) over nine non-overlapping sub-periods (1987-1989, 1990-1992, 1993-1995, 1996-1998, 1999-2001, 2002-2004, 2005-2007, 2008-2010 and 2011-2013). ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream.

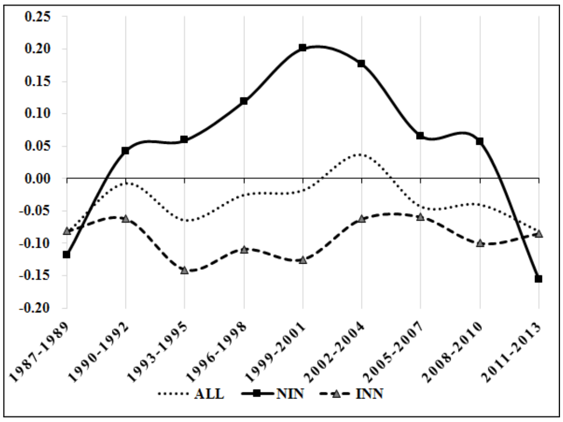
(a) AP-Ostliab



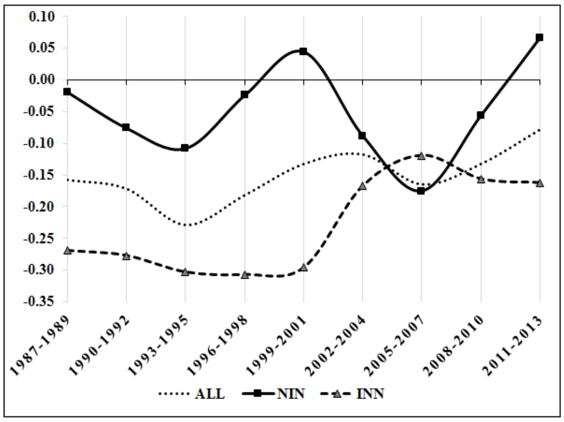
(b) AR-Ostliab



(c) AP-Cash



(d) AR-Cash



Appendix 6.D Net trade credit adjustments

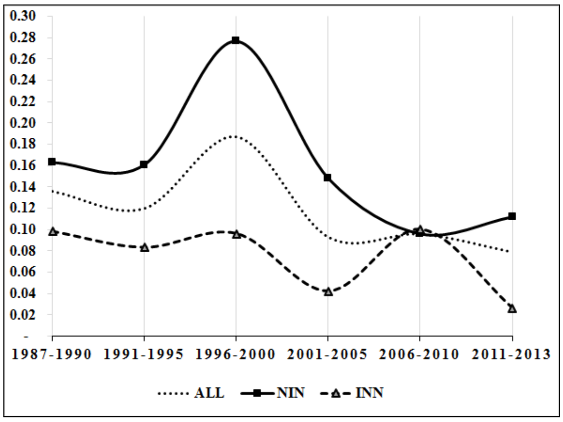
The table presents the results of estimating Equations (6.3) and (6.4) that relate changes in net trade credit (ΔNTC) to deviation from target net trade credit (Dev_{it}). ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. *RDD* a dummy variable that takes the value of one for firms that report R&D and zero otherwise. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1^{th} and 99^{th} percentiles. The data is drawn from Worldscope through Datastream. Standard errors (in parenthesis) are robust to autocorrelation and heteroskedasticity. All models include firm fixed effects and time dummies (not reported).***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	ALL	NIN	INN	ALL
Dev_{it}	0.251***	0.172***	0.340***	0.168***
	(0.024)	(0.020)	(0.042)	(0.019)
$Dev_{it} \times RDD$				0.165***
				(0.045)
N	7579	2945	4634	7579
$Adj.R^2$	0.115	0.069	0.164	0.124

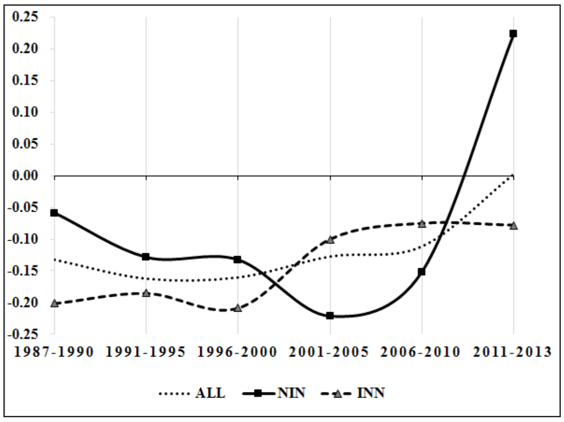
Appendix 6.E The sensitivity of net trade credit

The figure 6.2a and 6.2b plot the time series of the sensitivities of net trade credit from estimating Equations (6.1) and (6.2) over six non-overlapping sub-periods (1987-1990, 1991-1995, 1996-2000, 2001-2005, 2006-2010 and 2011-2013). The figure 6.2c and 6.2d plot the time series of the sensitivities of net trade credit estimating results of Equation (6.1) over nine non-overlapping sub-periods (1987-1989, 1990-1992, 1993-1995, 1996-1998, 1999-2001, 2002-2004, 2005-2007, 2008-2010 and 2011-2013). ALL represents all firms in the sample, NIN stands for non-innovative firms that do not report R&D, and INN stands for innovative firms that report R&D. The sample consists of non-financial firms in the UK with at least five years of data on key variables over the period from 1987 to 2013. All variables used are defined in Appendix 3.2 in Chapter 3, and are winsorised at the 1th and 99th percentiles. The data is drawn from Worldscope through Datastream.

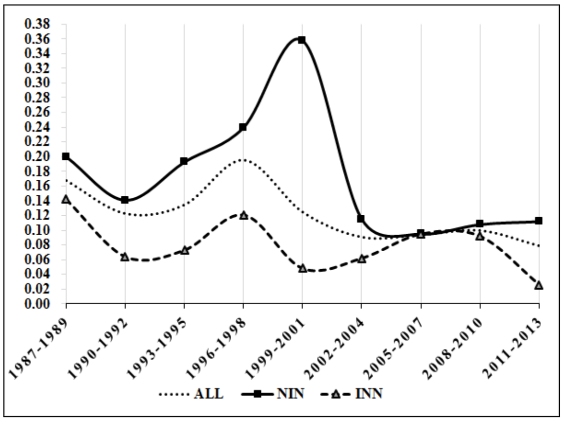
(a) NTC-Ostliab



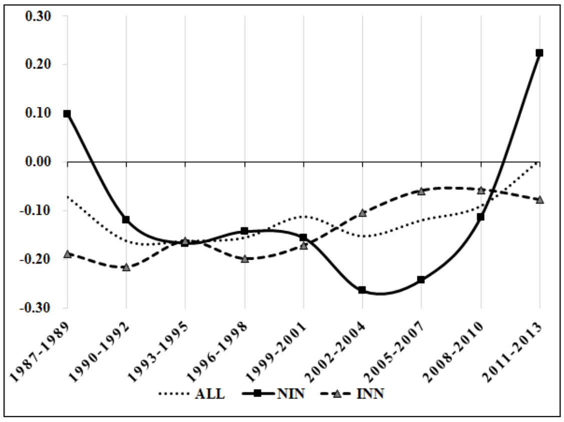
(b) NTC-Cash



(c) NTC-Ostliab (3 years)



(d) NTC-Cash (3 years)



Chapter 7

Summary, Limitations and Future Research

7.1 Background

Questions on how managers make corporate financing decisions, and the nature of the interactions between financing and real decisions (e.g., investment, employment, and production), remain open to debate despite several decades of research. Events from the global financial crisis (where over-assumption of debt at household, corporate and sovereign levels was one of the main causes of the crisis) also highlights the need to re-examine the interdependence of financing and real decisions. Recently, there has been a marked increase in R&D and changes in corporate balance sheets (in the form of increases in intangible assets and decreases in tangible assets), due to the increasing dominance of technological and service sectors. These marked changes in corporate investment and corporate assets expose firms to binding financial constraints, as intangible investments are characterised by high information asymmetry, long investment horizons, asset substitution problems, high specificity, and low collateral values. This increase in innovative investments should result in corporate de-leveraging as firms have less pledgeable assets when accessing debt financing.[1] However, corporate debt has remained relatively persistent, with an upward drift characterised by several temporary spikes. This is inconsistent with the expected de-leveraging to counteract the increase in operating risks (arising from increases in innovative investments) as predicted by the theory of Krainer (2014). Similarly, Graham et al. (2015) report a similar threefold increase in corporate leverage in the US over the past century, which they attribute to an increasing propensity to use debt financing over time.

Theory suggests several reasons why firms with a high proportion of R&D and intangible assets should prefer equity over debt financing. First, managers choose investment projects that conform to the risk aversion of the shareholders and use capital structure to offset any deviations from acceptable risk thresholds (see, Krainer, 2014). As highlighted in the literature, R&D and intangible assets increase operating

[1] Traditional finance theory posits that collateral reduces the incentive of borrowers to engage in actions that are detrimental to the creditors (see, Holmstrom and Tirole, 1997; Leland and Pyle, 1977; Leland, 1998).

risk, and this can be offset by adopting conservative financing structures (reducing debt financing). Second, the special nature of innovative investments favours equity financing as debt financing is costly and prohibitively restrictive given the need to adhere to the covenants. These covenants, that seek to protect creditors, may inadvertently reduce strategic flexibility (see, Hall, 2002; O'Brien, 2003) and require disclosure of information (proprietary information) which may harm innovative investments. The need to service debt may also result in managers prioritising liquidity management ahead of further investments in innovation as some projects do not generate revenues in the short-run. These special characteristics of intangible investments favour equity financing, which is less restrictive compared to debt financing.

Against this background, this thesis examines the differences in financing structure, leverage adjustments and trade credit policies of innovative and non-innovative firms using a sample of 817 (8 396 firm year observations) non-financial firms listed on the London Stock Exchange over the period 1987 to 2013.[2] There is a growing need to understand how the changing composition of corporate investments affects other corporate decisions (see, Buera and Kaboski, 2012). An examination of the differences between innovative and non-innovative firms provides insights on how investment types affect corporate financing decisions. Unlike prior studies that focus on one form of investment or adopt a *ceteris paribus* approach, which ignores the interrelations between these investments, this thesis examines concurrently the effects of these forms of investment on corporate financing decisions. This approach recognises the heterogeneity in corporate investments and the interdependence of corporate decisions (such as investment and capital structure). Further, an understanding of the time variations in the relationship between investment and financing decisions is important in light of the changing compositions of corporate investments.[3]

The rest of this chapter is organised as follows. Section 7.2.1 presents a summary of

[2]The focus on the UK addresses the confinement of studies to the US, which limits generalisability of results to other economies with different macroeconomic, institutional and legal frameworks.

[3]Several studies in the US report marked increases in R&D (e.g., Borisova and Brown, 2013; Brown and Petersen, 2011; Falato et al., 2013; Sporleder et al., 2002) and intangible assets (e.g., Falato et al., 2013; Lim et al., 2014; Loumioti, 2012).

the main results of the empirical analysis of Chapter 4 on the determinants of financing structure. Section 7.2.2 presents a summary of the main findings of the empirical analysis in Chapter 5 on leverage adjustments. Section 7.2.3 presents a summary of the main results of the empirical analysis of Chapter 6 which investigates the determinants of trade credit and the relationship between trade credit and cash, and trade credit and short-term debt. Section 1.3 presents the policy implications arising from the research. Finally, Section 7.3 presents the limitations and ideas for future research.

7.2 Summary of the main findings

7.2.1 Financing structure: The case of innovative versus non-innovative firms

Chapter 4 investigates the determinants of financing structure and the differences between innovative firms that report R&D and non-innovative firms that do not report R&D. The results of prior studies that investigate the determinants of financing structure and interdependence of financing and investment decisions are mixed.[4] One strand reports insignificant linkages (see, Mauer and Triantis, 1994), while another, either reports a positive (e.g., Lyandres and Zhdanov, 2005; Rashid and Caglayan, 2012) or a negative relationship (e.g., Aivazian et al., 2005; Dang, 2011; DeAngelo and Masulis, 1980; Lang et al., 1996). Further, Borisova and Brown (2013) highlight that most prior studies have focused largely on fixed capital investments (Capex), while overlooking the effects of the marked changes in corporate investments (the increase in R&D) over the recent decades and their implications on corporate financing decisions. Yet, there is a marked increase in innovation (R&D) and decrease in both fixed capital investments (Capex) and tangible assets as economies move from predominantly manufacturing sectors towards service and technology sectors.

[4]Recent reviews highlight that existing models only explain a low proportion of the variations in capital structure, with results on some factors being mixed and in some cases, the factors are becoming less reliable over time (see, Frank and Goyal, 2009; Graham and Leary, 2011; Oztekin, 2015).

The analysis of Chapter 4 adopts a de-compositional approach in which leverage is decomposed into four components (total debt, long-term debt, short-term debt and total liabilities) upon which comparisons of financing decisions of innovative and non-innovative firms are made. The adoption of a de-compositional approach is motivated by Rauh and Sufi (2010) who argue that debt is heterogeneous, and in line with DeAngelo and Roll (2015) and Welch (2004) who highlight that the components of leverage vary greatly over time even though aggregate leverage exhibits relative stability (as Lemmon et al. (2008) and Hanousek and Shamshur (2011) report). The special characteristics of innovative investments, which include long investment horizons, high information asymmetry, asset substitution problems, and poor collateral values, should result in the adoption of conservative financing structures. A model by Krainer (2014) shows that managers use capital structure to keep operating risks within thresholds that are acceptable to shareholders. Similarly, other theories by Arrow (1962) and Nelson (1959) predict that innovation should be financed with equity. The stakeholder co-investment theory of Titman (1984) also posits that firms with unique products are more likely to face binding constraints. Debt financing is also less preferred as the covenants associated with debt, which afford close monitoring, may inadvertently restrict strategic flexibility (see, O'Brien, 2003) and harm innovation by requiring disclosure of valuable information (see, Buera and Kaboski, 2012). Following these predictions, the increase in innovative investments should lead to a marked decrease in debt financing and observable differences in financing structures between innovative and non-innovative firms.

The results of the analysis presented in Chapter 4 show that leverage has not subsided, contrary to expectations built in response to the increase in innovative investments, but has remained largely persistent and rising. The persistence in corporate gearing is inconsistent with the increase in R&D and the decrease in collateral values, which should result in debt reductions. The results show similarities in financing structures of innovative and non-innovative firms, which is inconsistent with the predictions of the information asymmetry theory and most prior studies (e.g., Borisova and Brown, 2013; Brown and Petersen, 2009, 2011; Hall, 2009). The similarities in financing structure are consistent, however, with Chava et al. (2013) who report that specialist lenders are more willing to finance innovation, and with Stroebel (2015) who find that integrated lenders lend more than non-integrated lenders. The results further show that the relationship between leverage and capital expenditure is positive and significant on three measures of leverage, except for total liabilities. This suggests that capital expenditure has an insignificant effect on short-term debt, which is included in total liabilities. The results on tangible assets, growth, size, profit, and non-debt tax shield are mostly consistent with theory and prior studies, except for intangible assets that have a positive effect on leverage. This latter result is inconsistent with the literature that suggests that intangible assets should be financed mostly with equity. The coefficient of intangible assets is significant even though most intangible assets are off-balance-sheet items.[5] This result suggests that intangible assets facilitates access to debt financing in a similar way as tangible assets.[6] Further, the increase in debt financing over time can be attributed to the increasing propensity to use debt financing (see, Graham et al., 2015).

Comparisons of the determinants of leverage show variations between innovative and non-innovative firms. Leverage (except when measured by total liabilities) is relatively more persistent for non-innovative firms than innovative firms. This result is consistent with the hypothesis that physical capital investments support debt financing (see, Almeida and Campello, 2007; Campello and Giambona, 2013; Ortiz-Molina and Phillips, 2014). However, the insignificant difference in persistence on total liabilities shows that innovative and non-innovative firms adopt similar financing structures on aggregate. R&D has a consistently negative and significant effect on leverage, as is consistent with prior studies (e.g., Aghion et al., 2004; Borisova and Brown, 2013; Dang et al., 2014a; Elsas and Florysiak, 2013; Hall, 2002). However, this negative effect is inconsistent with the persistence in leverage and the similar

[5]ISA 38 restricts the recognition of intangible assets to those that arise from business combinations or are acquired from other firms.

[6]Similarly, Falato et al. (2013) report that 20% of the secured syndicated loans originated in the US are collateralised by intangible assets over the period 1996 - 2005.

debt financing levels of innovative and non-innovative firms. Rather, the persistence in leverage shows that innovative firms are able to access debt financing despite their focus on intangible investments. Capital expenditure has a positive effect on leverage for non-innovative firms, while this effect is consistently insignificant for innovative firms. The variations of the effect of capital expenditure across the four measures of leverage used highlight that the mixed results in the literature are due to the different definitions of leverage adopted in the literature, or the failure to take into account the heterogeneity in the effects of firm specific factors across different firm groups.[7]

Further comparisons show that the coefficients on tangible and intangible assets differ significantly between innovative and non-innovative firms, except when total liabilities is used as the measure of leverage. This exception is due to the inclusion of non-financial factors in total liabilities and is consistent with Rajan and Zingales (1995) who argue that measuring leverage using total liabilities is misleading as it includes non-financing factors that are mostly for transactional purposes. Tangible assets have a significant positive effect on leverage, and this effect is significantly higher for innovative firms, which face binding financial constraints. This result is consistent with theoretical predictions by Holmstrom and Tirole (1997), Leland and Pyle (1977) and Leland (1998) that collateral facilitates access to debt financing as it reduces information asymmetry. Similarly, the positive effect of intangible assets on leverage is consistently higher for innovative firms which have a larger proportion of non-physical assets. This result highlights the growing importance of the overlooked intangible assets on corporate balance sheets. The differences in the coefficients of the control variables between innovative and non-innovative firms are insignificant, except for size when examining net-debt. Net-debt increases significantly with size for non-innovative firms, but is negative and insignificant for innovative firms. This result suggests that large innovative firms with better access to capital markets prefer equity to debt as is consistent with the proposition that firms which invest in innovation seek to preserve flexibility (see, Buera and Kaboski, 2012; O'Brien, 2003).

[7] Barclay et al. (2006) argues that there is no reason to expect the same results from studies that use different definitions of leverage (market leverage and book leverage).

The analysis of Chapter 4 then investigates time variations in the effects of R&D, capital expenditure, tangible assets and intangible assets on leverage (total debt, net-debt, long-term debt, total liabilities). The analysis uses five non-overlapping sub-periods to investigate the changes in the sensitivity of leverage to investments (R&D and capital expenditure) and corporate assets (tangible/intangible assets). The results show that the relationships between leverage and R&D, and leverage and capital expenditure change over time in a way that explain the mixed results in the literature, where some studies (e.g., Lyandres and Zhdanov, 2005; Rashid and Caglayan, 2012) report a positive relationship, while others (e.g., Aivazian et al., 2005; Dang, 2011; DeAngelo and Masulis, 1980; Lang et al., 1996) report a negative relationship. Similarly, there are also significant time variations in the relationships between leverage and tangible assets, and leverage and intangible assets. The results show that intangible assets and intangible assets have a significantly positive effect on leverage (total debt, net-debt and long-term debt) and this effect is higher for innovative firms than non-innovative firms. This implies that collateral enables access to debt financing by reducing information asymmetry risks (see, Berger et al., 2005). The role of collateral in reducing information asymmetry risks over time is consistently and significantly higher for innovative firms that face binding financial constraints than non-innovative firms. The results from the analysis in Chapter 6 also show that the positive effect of tangible assets decreases over time for non-innovative firms, while it increases for innovative firms. This result is consistent with Falato et al. (2013) and show that an increasing proportion of debt financing is being secured by (used to finance) intangible assets. Similar changes and differences are also observable on intangibles assets. These changes show significant time variation and heterogeneity, across innovative and innovative firms, in the role of investments and corporate assets on leverage.

Overall, the analyses presented in Chapter 4 show that on aggregate, innovative and non-innovative firms adopt similar financing structures, but a de-compositional analysis shows significant differences in the effects of investments and corporate assets on leverage. The similar financing structures and persistence in leverage suggest that innovative firms are able to access debt financing. At policy level, there is a growing need for improving financing of innovation, especially that innovative investments are a major driver of economic growth.

The next section presents a summary of the main results of the empirical analysis of Chapter 5, which examines the differences in leverage adjustments between innovative and non-innovative firms.

7.2.2 Leverage adjustments: The case of innovative versus non-innovative firms

The empirical analysis in Chapter 5 investigates target financing behaviour and the differences in leverage adjustments between innovative and non-innovative firms. The analysis also examines asymmetry and time variation in target financing behaviour, which have been overlooked in prior studies.[8] The speed of adjustment is estimated using a two-step procedure in which the target leverage is estimated first based on firm specific factors and then used in a second stage to estimate the speed of adjustment.[9] This two-step procedure is preferred to the one-step procedure as it allows one to directly examine asymmetries in target financing behaviour.[10]

The focus on target financing behaviour and the differences in leverage adjustments between innovative and non-innovative firms is motivated by the mixed results in the literature on target financing behaviour and the limited studies on the effects of investments on corporate decisions. Prior studies on target financing behaviour report decidedly mixed results, even within the US market where studies are concentrated.

[8] A few studies investigate asymmetries in target financing behaviour (see, Dang et al., 2014a; Elsas and Florysiak, 2011; Lockhart, 2014; Warr et al., 2012). However, these studies focus on the US and do not examine asymmetry arising from differences in corporate investments.

[9] The target leverage in the first stage is estimated using system GMM and then, the speed of adjustment in the second stage is consistently estimated using OLS with fixed effects. Elsas et al. (2013), Faulkender et al. (2012) and Warr et al. (2012) highlight that once the target leverage has been estimated using system GMM, empirical models in the second stage can be consistently estimated using OLS.

[10] The one-step procedure involves estimating the speed of adjustment jointly with the coefficients of the determinants of capital structure.

For example, Dang et al. (2014a) (31% - 33%), Flannery and Rangan (2006) (34% - 36%), Huang and Ritter (2009) (17% - 23%), Lemmon et al. (2008) (25%) and Lockhart (2014) (50% - 77%) report moderate to high speeds of adjustment, while Fama and French (2002) and Kayhan and Titman (2007) report that US firms adjust leverage at a relatively slow rate of 7% - 18% and 8.3% - 10%, respectively. Similarly, Chang and Dasgupta (2009), Chen and Zhao (2007), Iliev and Welch (2010) and Welch (2004) report limited or no adjustments. This casts doubts on the predictions of the trade-off theory that firms have a target capital structure and that they actively re-balance their capital structure towards the target.[11]

Furthermore, existing studies mostly focus on fixed capital investments despite the marked increases in innovative investments. Recent studies have also emphasised the importance of investigating the effects of changes in firm composition on corporate decisions such as cash holdings and capital structure (see, Buera and Kaboski, 2012; Krainer, 2014).[12] There are several reasons why innovative and non-innovative firms may adjust leverage at different speeds. First, the high uncertainty and information asymmetry associated with innovation subjects innovative firms to binding financing constraints which reduce flexibility in adjusting towards a target leverage. These constraints arise due to the high information asymmetry, asset substitution problems, poor collateral values, and long investment horizons associated with innovative investments. Such constraints manifest in the form of limited access to capital markets, high cost of capital, and restrictive debt covenants. The restrictive covenants that are aimed at protecting creditors tend to reduce the ability to adjust leverage and limits strategic flexibility.[13] Second, the high operating risks and bankruptcy costs associated with innovation may prompt managers to actively adjust leverage to manage risk or reduce bankruptcy costs.[14] These opposing predictions on

[11]Huang and Ritter (2009) also highlight that questions on whether firms engage in target financing behaviour and the rate at which they adjust towards the target capital structure are amongst the most important issues in the literature.

[12]Krainer (2014) highlights the need to re-look at the important linkages between finance and real decisions in the aftermath of the recent global financial crisis where leverage was one of the main causes of the crisis.

[13]According to O'Brien (2003), strategic flexibility is crucial for survival in competitive markets for innovation.

[14]The model of Krainer (2014) posits that managers use capital structure to keep operating risks

how innovation affects leverage adjustments and the mixed results in the literature on target financing behaviour motivate this research.

The empirical analysis of Chapter 5 starts by estimating the target leverage based on lagged leverage, R&D, capital expenditure, tangible assets, intangible assets, growth, size, profit, non-debt tax shield, and volatility. The significant coefficients on lagged leverage suggest that firms have a target leverage as predicted by the trade-off theory. The implied speed of adjustment, $(1-\lambda)$, for all firms, non-innovative and innovative firms is 24.2%, 17.7% and 32.4%, respectively. This relatively slow to moderate implied speed of adjustment is consistent with the existence of adjustment costs and with prior studies. Comparisons of the implied speed of adjustment show that innovative firms are more active in re-balancing leverage towards the target than non-innovative firms. The results on the effects of investment show that capital expenditure has a positive effect on leverage, while R&D has a negative effect. The difference of the effect of capital expenditure on leverage between innovative and non-innovative firms is marginally significant. Further results show that intangible assets and tangible assets have a positive effect on leverage and their effect on leverage significantly differs between innovative and non-innovative firms. This implies that intangible assets play a similar role as tangible assets in supporting access to debt financing. The positive effect of intangible assets and tangible assets is significantly higher for innovative firms than for non-innovative firms. These preliminary differences show that investment and corporate assets have an important effect on the variations in target financing behaviour. The results on the effects of the control variables (growth, size, profit, NDTS and volatility) on leverage show that they do not significantly differ between innovative and non-innovative firms, but are mainly consistent with theoretical predictions and with prior studies.

Following the estimation of the target leverage in the first stage, the next step involves estimating the speed of adjustment. Using the two-step approach allows for an examination of asymmetry in target financing behaviour. The estimated average

within levels that are consistent with the risk aversion of shareholders.

speed of adjustment of 34.9%, assuming homogeneous target financing behaviour, is slow to moderate and is consistent with the existence of adjustment costs. Further analyses that allow for asymmetry in leverage adjustment between innovative and non-innovative firms show significant differences, with innovative firms exhibiting a significantly higher speed of adjustment than non-innovative firms. This result is consistent with the hypothesis that firms that face high operating risks and bankruptcy costs more actively re-balance capital structure as the costs of deviating from the target are substantially higher. Non-innovative firms take almost twice (28.3% which implies 2.08 years) the time taken by innovative firms (44.8% which implies 1.17 years) to adjust towards the target.[15] This difference in the speed of adjustment shows that investment type explains some of the observed variations in target financing behaviour even after controlling for other standard determinants of capital structure.[16]

Further analyses of leverage adjustments assuming asymmetry conditional on the initial deviation from the target show that the speed of adjustment is relatively higher for firms that are above-target leverage (44.2% or 1.19 years) than for firms that are below-target leverage (27.8% or 2.13 years). This significant difference between above-target and below-target leverage firms is consistent with the proposition that the costs and benefits of adjustment vary with the initial deviation from target.[17] The results in Chapter 5 further show that asymmetry in leverage adjustments is more apparent when investment type is examined (innovative firms *versus* non-innovative firms). The speed of adjustment of innovative firms that are above-target leverage (51.9%) is one-and-half times faster than that of non-innovative firms that are above-target leverage (34.9%). Similar differences are also observable for firms that are below-target leverage, with innovative firms exhibiting a speed of adjustment of 37.5% relative to 24.1% for non-innovative firms. The relatively high speed

[15] The half-life convention implies that the time take to adjust towards the target is computed as $ln(0.5)/ln(1-\lambda)$, where λ is the estimated speed of adjustment.

[16] This result is qualitatively similar to that obtained using the one-step approach that involves the joint estimation of the target leverage and the implied speed of adjustment.

[17] Byoun (2008), Faulkender et al. (2012) and Warr et al. (2012) report similar asymmetries based on whether the firm is above or below the target leverage.

of adjustment of innovative firms is consistent with the proposition that firms that face high financial distress costs benefit more from re-balancing capital structure.[18] The main contribution to the literature from these results is to show that firms that invest in innovation adjust capital structure more actively than non-innovative firms which face comparatively lower operating risks and financial distress costs. This implies that the costs and benefits of adjusting leverage are asymmetric conditional on investment type.

The analysis of Chapter 5 also investigates the effects of financing deficits on leverage adjustments. Assuming symmetric leverage adjustments, the results show that a financing deficit reduces the speed of adjustment for non-innovative firms by 10%, while it increases the speed of adjustment of innovative firms by 13.7% (from 35.9% to 49.6%). A further examination of asymmetry in target financing behaviour between firms that are above-target leverage and firms that are below-target leverage shows that the speed of adjustment increases with a financing deficit for firms that are above-target leverage, while it decreases for firms that are below-target leverage. This result shows that innovative firms are more likely to take the opportunity presented by the financing imbalances to adjust leverage than non-innovative firms. The increase in the speed of adjustment for innovative firms with a financing deficit is consistent with Byoun (2008) and Dang et al. (2014a) (in the US) who report that financing imbalances offer the opportunity to adjust leverage at comparatively lower costs. The results from the analysis in this chapter further show that much of the leverage adjustments in response to the need to cover financing imbalances is done by innovative firms that face binding financial constraints and higher costs of deviating from the target capital structure. Financing imbalances allows innovative firms to reduce the costs of adjusting leverage as these are spread over the need to adjust leverage and also cover the financing imbalance.

Time variation in leverage adjustments has not been analysed in depth in the lit-

[18] Krainer (2014) develops a model which shows that capital structure is used to keep operating risk within the thresholds that are commensurate with the risk appetite of the shareholders.

erature. Yet, several theoretical studies show that corporate decisions vary over time (see, Bhamra et al., 2010; Chen, 2010; Levy and Hennessy, 2007). Using 5-year rolling regressions, the analysis in Chapter 5 also investigates time variation in leverage adjustment. The time series plots of the deviation from the target leverage show that large positive shocks coincide with major macroeconomic events, while periods after major macroeconomic events are characterised by large negative shocks. The negative shocks suggest that firms reduce leverage as is consistent with the deleveraging propositions in the aftermath of macroeconomic shocks. An examination of the speed of adjustment over time shows that there are significant time-variations and asymmetries in target financing behaviour. The time series plots of the speed of adjustment show that, on aggregate, firms adjust leverage at a slow to moderate speed, which is consistent with the existence of adjustment costs. Further, empirical evidence is provided that innovative firms consistently adjust faster than non-innovative firms over time. This result implies that innovative firms are more active in re-balancing leverage, which is consistent with the predictions of the model of Krainer (2014) that managers use capital structure to manage risk. Further, the time series plots show that the average speed of adjustment of all firms fluctuates around 30%, while that for innovative firms exhibits significantly more variation over time than that of non-innovative firms.[19] This is clear evidence that much of the leverage adjustments are done by innovative firms that face higher costs of deviating from the target. The time variation in leverage adjustment also suggests that the mixed results in the literature could be due to the failure to account for the changes in the speed of adjustment over time or heterogeneity in target financing behaviour conditional on the forms of corporate investment.

The significant differences in the speed of adjustment between innovative and non-innovative firms make a strong argument that asymmetries, changes in firm composition, and time-variations are important in understanding the observed heterogene-

[19]The relative stability of the speed of adjustment for all firms over time is inconsistent with the prediction that efficiency is improving in financial markets (Philippon, 2015) and the importance of target financing behaviour (Huang and Ritter, 2009). Rather improvements in information technology should result in an increase in the speed of adjustment as result of the decrease in information asymmetry and costs of issuing or retiring securities.

ity in target financing behaviour. The results also suggest that firms that invest in innovation are more active in re-balancing leverage as capital structure is used to manage risks. This higher speed of adjustment for innovative firms implies that the costs of deviating from target increase with investments in innovation.

The next section presents a summary of the main results of the empirical analysis of Chapter 6, which examines the determinants of trade credit and the differences in trade credit between innovative and non-innovative firms.

7.2.3 Trade credit: The case of innovative versus non-innovative firms

The empirical analysis of Chapter 6 investigates the determinants of trade credit, trade credit adjustments, and differences in trade credit policies between innovative and non-innovative firms. The analyses in Chapter 6 are motivated by the few studies on trade credit despite its importance as a source of short-term financing, particularly during periods characterised by contractions in bank lending.[20] Over the sample period 1987 to 2013, accounts payable (accounts receivable) accounted for 13.4% (22.8%) of total assets. Despite this importance of trade credit in capital structure, little is known about the causes of the observed heterogeneity in trade credit policies, and how trade credit relates to other sources of firm financing. The few studies that examine the relationship between trade credit and short-term debt report mixed results and are more concentrated in the US. The analysis in Chapter 6 builds on these prior studies and examines time series and cross-sectional variations in the relationship between trade credit, and other forms of financing (which also include cash holdings) in the UK, where studies are rather limited.

[20]Several studies highlight the importance of trade credit as a form of short-term financing. For example, Rajan and Zingales (1995) report that in 1991 trade credit represented 17.8% of firm assets in the US, 22% in UK, and over 25% in other countries. Similarly, Demirguc-Kunt and Maksimovic (2001) report that trade credit accounts for 25% firms' total assets in countries such as France, Germany, and Italy, and Aktas et al. (2012) report that trade credit is on average between 10% and 15% of total assets in the US. Petersen and Rajan (1997) also report that trade credit is 17% of current assets in the US, while Wu et al. (2012) report ranges from 11% and 15% of total assets for firms in China. For prior studies on the importance of trade credit as a source of short-term finance, see Aktas et al. (2012), Demirguc-Kunt and Maksimovic (2001), Petersen and Rajan (1997), Rajan and Zingales (1995) and Wu et al. (2012).

The focus on differences between innovative and non-innovative firms is motivated by the increase in innovative investments (the rise in R&D and intangible assets), with innovative firms increasing over the sample period.[21] The role of trade credit in firm financing is likely to differ across innovative and non-innovative firms as the former are subject to binding financial constraints that limit access to other forms of financing (see, Borisova and Brown, 2013; Brown et al., 2012). Innovative firms may in-turn advance more credit to their customers as a form of guarantee on product quality.[22] This results in two empirically testable propositions on the variations in the use of trade credit. First, as innovative firms are more likely to be credit constrained, they may resort to other forms of financing such as trade credit.[23] Second, the presence of credit constraints and the high costs of using trade credit may also discourage the use of trade credit as a form of short-term finance (e.g., Lin and Chou, 2015; Petersen and Rajan, 1994, 1995). Further, the short-term nature of trade credit tends to reduce flexibility, which is critical for survival in competitive markets for innovation (O'Brien, 2003). The specialised nature of innovative products may also necessitates the provision of trade credit to customers since trade credit is a form of warranty on product quality (see, Wilner, 2000).[24] The implication of the second proposition is that established and reputable suppliers need not provide trade credit because their reputation dispenses with the need to provide a product warranty (see, Long et al., 1993). Similarly, firms producing standardise products should give less trade credit (see, Guariglia and Mateut, 2013; Giannetti et al., 2011). These opposing predictions and mixed results on trade credit highlight the need for further research,

[21] Borisova and Brown (2013) and Brown and Petersen (2011) also report that R&D now exceeds capital expenditure in the US.

[22] Long et al. (1993) posits that firms use trade credit as a warranty on product quality which implies that large and more reputable firms provide less trade credit.

[23] A model of Wilner (2000) posits that financially constrained firms may agree to pay higher implied rates in trade credit contracts as they anticipate larger renegotiation concessions from long-term or more dependent suppliers in case of bankruptcy. Consistent with this proposition, Evans (1998) and Wilner (2000) report that suppliers tend to grant more concessions in case of financial distress than would be granted by lenders in competitive credit markets. Similarly, Petersen and Rajan (1994) and Wilner (1997) report that financially constrained firms are more reliant on trade credit than unconstrained firms.

[24] According to Antràs and Foley (2011), Lee and Stowe (1993) and Long et al. (1993), trade credit acts as a form of guarantee on product quality as it allows the customer to try the product before making a payment.

with a particular emphasis on the cross-sectional and time series variations between innovative and non-innovative firms.

Further, Chapter 6 examines the time variations on the relationship between trade credit and short-term debt and between trade credit and cash holdings. The focus on time variations in the sensitivity of trade credit to other forms of short-term finance is motivated by the considerable debate on whether trade credit is a substitute or a complement to other forms of financing (see, Ferrando and Mulier, 2013; Giannetti et al., 2011; Love et al., 2007; Yang, 2011b). For example, Yang (2011b) reports that the relationship between bank credit and trade credit varies with monetary policy. Similarly, Meltzer (1960) reports that the relationship between trade credit and other forms of short-term finance changes with the monetary cycle.[25] The analysis presented in Chapter 6 also examines trade credit adjustments as extant studies have largely overlooked the dynamic nature of the decision to give or take trade credit.[26] Trade credit is thought to be influenced by current or future credit policy, competitors, and market conditions. Also, customers who are used to getting credit usually expect to continue getting goods or services on credit. This suggests that firms have a target trade credit level, which should be more important for innovative firms than non-innovative firms if the former face binding financial constraints and use trade credit to alleviate information asymmetry in the product market.

The results in Chapter 6 show a secular decrease in trade credit, with accounts payable (accounts receivable) decreasing from a peak of 17.4% (26.8%) in 1996 to a low of 9.4% (14.5%) in 2009. Despite this marked decrease, public firms in the UK have remained net suppliers of trade credit by extending more trade credit than they receive. Comparisons suggest that the decrease in accounts receivable is relatively more pronounced for non-innovative firms from 2006 to 2011, with these firms advancing less credit during the global financial crisis. This is consistent with propo-

[25] Also, Meltzer (1960) and Yang (2011b) report that periods marked by tight or loose monetary policy change the relationship between trade credit and short-term debt.

[26] Prior studies adopt a non-dynamic approach to analyse trade credit, see Dass et al. (2014), Garcia-Appendini and Montoriol-Garriga (2013), Lin and Chou (2015), Love et al. (2007), Klapper et al. (2012), Mizen (2008), and Wu et al. (2012); Yang (2011a).

sition that firms with less specialised products extend less trade credit (see, Long et al., 1993). On average, non-innovative firms use more, or give less, trade credit than innovative firms. The trends on trade credit, however, are inconsistent with the proposition that firms with greater access to capital markets (non-innovative firms in this case) use this advantage to benefit their customers by giving them more trade credit. Rather, the data shows that supposedly constrained firms (innovative firms) give relatively more trade credit. This is consistent with the proposition that firms with specialised products give more trade credit as a form of warranty for product quality. Firms with better access to capital markets use this advantage to benefit their customers by providing more trade credit. The provision of trade credit helps alleviates information asymmetry in the financial markets as it is used by banks as a credible signal of good credit and in the product market as it gives customers the opportunity to try the product before making a payment.

The results show that accounts payable is significantly negatively related to other short-term liabilities, cash, tangible assets, intangible assets, size, profit, and volatility, while it is significantly positively related to asset turnover. The highly significant negative effect of other short-term liabilities on accounts payable is consistent with the proposition that firms that have access to other short-term financing sources rely less on trade credit (see, Meltzer, 1960). The likely reasons are that trade credit tends to restrict flexibility and is often difficult to roll-over, especially during periods characterised by contractions in credit supply.[27] Cash has a negative effect on trade credit, on average, which shows that firms use excess cash to reduce the relatively expensive trade credit (accounts payable) and have to reduce trade credit extended (accounts receivable) in-order to build up cash reserves. Comparisons between innovative and non-innovative firms show that cash has an asymmetric effect on trade credit. Cash has a significant negative effect on accounts payable and accounts receivable of innovative firms, while it has an insignificant positive effect on accounts

[27] Similarly, O'Brien (2003) reports that short-term debt tend to restrict flexibility, which is critical in highly competitive and innovative product markets. Also, Diamond (1991) and Hart and Moore (1994) present models which show that firms match the maturity of assets and liabilities, which implies that innovative firms with investments that have long horizon will use less short-term financing sources.

payable and a marginally significant negative effect on accounts receivable of non-innovative firms.[28] The differences on the effect of other short-term liabilities and cash on trade credit imply that other-short term liabilities and cash play different roles in firm financing decisions for innovative and non-innovative firms.

An examination of the sensitivity of trade credit to cash and other short-term liabilities reveals significant variations over time and between innovative and non-innovative firms. Other short-term liabilities have a consistent substitution effect on trade credit (accounts payable), with this substitution effect being significantly higher for non-innovative firms that face less binding financial constraints. This high substitution effect for innovative firms is consistent with studies that show that the implied interest costs on most trade credit contracts is much higher than other sources of short-term financing (see, Lin and Chou, 2015; Ng et al., 1999; Wilner, 2000). There are also similar differences on the effect of cash on trade credit, with cash being largely a compliment to trade credit (accounts payable) for non-innovative firms, while it is a substitute to trade credit (accounts payable) for innovative firms. This result suggests that non-innovative firms do not use the excess cash to reduce the relatively expensive financing from trade credit. Further comparisons on the the sensitivity of accounts receivable (trade credit extended) to other short-term liabilities and cash show similar, and significant differences between innovative and non-innovative firms. Short term liabilities act mainly as a compliment to trade credit extended (accounts receivable), but change to being a substitute during the periods 2001-2005, 2006-2010 and 2011-2013 for non-innovative firms. There are similar differences when comparing of the sensitivity of trade credit extended (accounts receivable) to cash, with the relationship between cash and trade credit extended being mostly negative, but is rather less significant and changes to positive for non-innovative firms over the period 2011-2013. These difference show the importance of studying the dynamic nature of the relationship between trade credit and other short-term sources of financing (short-term debt and cash), and the heterogeneity in

[28]The positive relationship between cash and trade credit for non-innovative firms is consistent with Love et al. (2007) who report that firms in emerging markets do not reduce reliance on the relatively expensive credit from suppliers even though they have better liquidity positions.

trade credit arising from differences in corporate investments (innovative firms *versus* non-innovative firms).

Finally, the results show that, on average, firms adjust trade credit towards the target at a slow to moderate speed of 20.1% for accounts payable and 17.4% for accounts receivable. This slow speed is consistent with the existence of adjustment costs. Adjustment costs tend to impede firms from fully adjusting towards the target trade credit level as they seek to maximise firm value. Comparisons of the speed of adjustment between non-innovative and innovative firms show that innovative firms consistently adjust trade credit faster than non-innovative firms. Innovative firms adjust accounts payable (accounts receivable) at a speed of 23.7% (22.3%), while non-innovative firms adjust at a speed of 16.2% (12.9%). The differences in the speed of adjustment are highly significant for accounts payable (7.5%) and marginally significant for accounts receivable (9.4%). This implies that the costs of deviating from target, or the benefits of adjusting towards the target, are relatively higher for innovative firms than non-innovative firms as innovative firms face binding financial constraints or high costs of bankruptcy. The existence of these high financial distress costs motivates managers to more actively adjust their financing policies, which include trade credit. These differences show the importance of recognising heterogeneity in trade credit conditional on investment types, as innovative firms benefit more from adjusting trade credit towards the target than non-innovative firms.

Overall, the results in Chapter 6 show that innovative (non-innovative) firms give more (less) trade credit to their customers and take less (more) goods on trade credit from their suppliers. The results also show that the effect of cash on trade credit is asymmetric as cash holdings and accounts payable have a complimentary relationship for non-innovative firms, whereas they are substitutes for innovative firms. This suggests that innovative firms tend to substitute trade credit with short-term debt as trade credit is a relatively more expensive form of short-term financing. Further, innovative firms rely less on trade credit as it also reduces flexibility given that it is often difficult to roll over. Evidence is also presented of significant time variations in the relationship between trade credit and short-term debt, and between trade credit and cash holdings, and significant variation in trade credit across investment type. The results reveal that firms in the UK have a target trade credit level and that they adjust towards the target at a slow to moderate speed due to adjustment costs. The higher speed of adjustment for innovative firms relative to non-innovative firms also show that innovative firms more actively re-balance trade credit towards the target so as to minimise the costs of deviating from target or maximise firm value. The differences suggest that innovative and non-innovative firms adopt heterogeneous trade credit policies.

The next section presents the limitations and suggestions for future research arising from the analyses in this thesis.

7.3 Limitations and future research

While this thesis investigates the differences in financing decisions of listed innovative and non-innovative firms, it would be interesting to examine whether investment type causes heterogeneity in corporate decisions of firms in the private sector. Extending the analyses in this thesis to the private sector can add further insights as innovations are made mostly by private firms. Little is known about corporate decisions of private firms, which are more credit constrained by nature (no access to public markets). Only a few studies examine corporate decisions of private firms (e.g., Brav, 2009; Frank and Goyal, 2008; Goyal et al., 2011). However, these studies do not examine how investment type (innovative firms *versus* non-innovative firms) causes cross-sectional variations in corporate decisions, and are more concentrated in the US which limits the generalisation of the results to other economies. It would also be interesting to compare the differences on the effect of changes in corporate investments (the increase in R&D and decrease in physical capital expenditure) on corporate decisions of public and private firms. Moreover, an analysis of cross-country variations might reveal important insights, especially that innovation is now a major driver of economic growth in many economies.[29] Further, differences in access to capital markets can inform on public policy aimed at promoting innovation.

While the focus on the UK enables an in-depth analysis of corporate decisions in the UK economy, there is a need to extend the study to other economies.[30] Investigating other countries with different macroeconomic conditions, and legal and institutional frameworks would be fruitful. This would contribute to extant studies that show that corporate decisions are influenced by macroeconomic conditions, and legal and institutional frameworks (e.g., Cook and Tang, 2010; Jõeveer, 2012; Korajczyk and Levy, 2003; Malmendier and Nagel, 2011). Such an analysis, therefore, would be informative, particularly on how macroeconomic factors jointly influence the interdependence of corporate financing and investment decisions. Antoniou et al. (2008) and Oztekin and Flannery (2012) report that differences in the legal and institutional environments between the US and the UK explain some of the cross-country variations in capital structure. Further, there are limited studies on the effects of shareholding structure on financing and investment decisions, particularly in economies other than that of the US. Yet, shareholder structure affects most corporate decisions in general, and in under-developed markets in particular (e.g., Huang and Song, 2006; Marchica, 2005; Vincent and Michaely, 2012). A study that investigates the relationship between shareholding structure (which can include government shareholding and shareholder dispersion) and innovation, can add important insights on the interdependence of corporate decision as the economies transit towards technological and service-based sectors.

The interdependence of corporate decisions has not been comprehensively investigated, with extant work adopting a *ceteris paribus* approach in which one decision

[29] Although the link between innovation and economic growth is well established (see, Akcigit and Kerr, 2015; Atanassov et al., 2007; Levine, 2005; Michalopoulos et al., 2009; Stulz, 2000), the channels through which innovation relates to financing decisions is rather unclear (see, Stein, 2003).

[30] Only US company accounts are available on a consistent quarterly and annual intervals, which restricts the study of corporate decisions in other countries. Data on other countries is only available annually with gaps due to missing observations. This limits the sample size and the length of the studies.

is fixed while another is examined.[31] Although this approach is parsimonious, it overlooks the simultaneous and inter-temporal nature of corporate decisions. To my knowledge, Gatchev et al. (2010) is the only empirical study that investigates the inter-temporal nature of corporate decisions. Several corporate decisions are interdependent as they involve a joint determination of many aspects of corporate strategy, and often compete for the same limited resources. Although there is consensus that financing decisions are interdependent in the presence of market imperfections which is contrary to the propositions of Modigliani and Miller (1958), Chava and Roberts (2008) and Stein (2003) highlight that the channels through which they relate are unclear. It would be interesting to investigate how investment type (R&D, human capital, working capital, capital expenditure) affect other corporate decisions in a dynamic framework that incorporates the simultaneous and inter-temporal nature of corporate decisions.

The asymmetry in corporate decisions is a promising area for future research as it addresses several limitations in prior studies that assume homogeneous target financing behaviour. The analyses in this thesis highlight significant asymmetries in corporate decisions arising from differences in corporate investment. A possible extension would involve looking at the extent to which other factors (e.g., large investments, human capital, cost of capital, and shareholding structure) are involved in the causing heterogeneity in target financing behaviour. A review of the literature by Graham and Leary (2011) highlights the need to expend more effort in identifying potential, or new, factors that could explain observed variations in capital structure. Heterogeneity in corporate investments affect other corporate decisions, and may explain, at least partially, the observed variations in financing and liquidity management policies. Similarly, Krainer (2014) develops a model showing important interdependence between real and financing decisions. However, there are limited studies that examine the channels through which corporate decisions relate (see, Dang, 2011; Chava and Purnanandam, 2011; Stein, 2003). As the results show significant time

[31] Recently, Dang (2011) highlights the need to consider the dynamic nature of the interdependence of corporate decisions.

variations in the relationship between financing and investment variables, there is a need to examine the causes, and how these relate to changes in firm composition and macroeconomic conditions.

There is a growing interest in gaining a clearer understanding of the determinants of capital structure through de-compositional analyses (see, Bevan and Danbolt, 2002; Hertzel and Li, 2010; McNichols et al., 2010; Rauh and Sufi, 2010). Similarly, Graham and Leary (2011) and Titman and Wessels (1988) also highlight that studies on capital structure are fraught with imperfectly measured variables. They highlight that the *ceteris paribus* approach of focusing only on one factor at a time, and which is adopted by extant studies, tends to overstate the importance of that factor as it is an imperfect proxy of the true variable, and ignores the interdependent nature of corporate decisions. Several studies report improvements in model fit from de-composing the determinants of capital structure (see, inter alia, Bevan and Danbolt, 2002; Campello and Giambona, 2013; Chang et al., 2014; Erickson and Whited, 2012; Liu, 2009; McNichols et al., 2010, 2014; Rauh and Sufi, 2010). According to Graham and Leary (2011), there is also a need examine the off-setting effects of the dis-aggregated variables on capital structure. This study contributes in this regard by showing that investment type is one source of the observed heterogeneity in financing and trade credit policies.

Although trade credit has remained an important source of short-term financing, it has been under studied, partly due to lack of information, as Petersen and Rajan (1997) highlight. There is a need to better understand the determinants of trade credit and why firms adopt heterogeneous trade credit policies. While this thesis is focused on trade credit policies of listed firms, an extension of the analyses to examine other aspects of cross-sectional variations, such as legal, institutional, and macroeconomic conditions, might be useful. Further, trade credit policies of private firms, which constitute the majority of firms in most economies, have not been examined. The focus on trade credit policies of private firms would add new insights on how access to capital markets affects these policies. A study that matches the supplier of trade credit with the users, encompassing both public and private firms, can show how firms with better access to financing use their comparative advantage to benefit customers. There is also a need to understand and quantify the costs of trade credit and how innovation in financial markets is affecting trade credit policies. Along similar lines, Philippon (2015) surprisingly shows that the costs of financial intermediation have not decreased in response to improvements in information technology. The analyses in this thesis can be extended to examine the variations in the costs of trade credit, which are considerably higher than those of public debt as shown in prior studies (e.g., Lin and Chou, 2015; Ng et al., 1999; Wilner, 2000). Variations in the costs of providing loans or credit reveal important information on how technological advancements affect financing or capital markets. The results can also inform on public policy related to improvements in efficiency and changes in access to capital markets.

Overall, the results in this thesis highlight the need to examine heterogeneity and time variation in corporate decisions. Focusing on these two important aspects has the potential to add new insights on how corporate decisions and firm characteristics evolve over time.

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